FINAL

FEASIBILITY STUDY
LANDFILL 7 AND FIRE PROTECTION TRAINING AREA 1
ZONE D, OPERABLE UNIT 10

F. E. Warren Air Force Base, Wyoming

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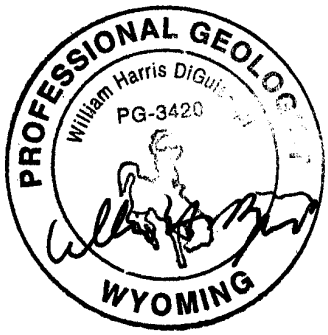

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BMP	Best Management Practice
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
COPEC	contaminant of potential ecological concern
CY	cubic yards
DAF	dilution attenuation factor
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPCRA	Emergency Planning and Community Right-to-Know Act
ERA	ecological risk assessment
ESA	Endangered Species Act
FEW	F.E. Warren Air Force Base
FPTA	Fire Protection Training Area
FS	Feasibility Study
FWS	U. S. Fish and Wildlife Service
GCL	geosynthetic clay liner
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HI	hazard index
HQ	hazard quotient
IDW	invesitgation derived waste
IRP	Installation Restoration Program
LCY	loose cubic yards
LOAEL	lowest observable adverse effect level
LTM	long-term monitoring
mg/kg	milligrams per kilogram
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Soild Waste and Emergency Response
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PPE	personal protective equipment

LIST OF ACRONYMS AND ABBREVIATIONS (CONT.)

PVC	polyvinyl chloride
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SSL	soil screening level
TBC	to be considered
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TMV	toxicity, mobility, or volume
TPH	total petroleum hydrocarbon
TRV	toxicity reference value
UCL	upper confidence limit
UCL95	95 percent UCL
USAF	United States Air Force
USC	United States Code
UXO	unexploded ordnance
VOC	volatile organic compound
WCA	Waste Consolidation Area
WDEQ	Wyoming Department of Environmental Quality
WHWRR	Wyoming Hazardous Waste Rules and Regulations
WWQRR	Wyoming Water Quality Rules and Regulations

EXECUTIVE SUMMARY

This report documents the methods and findings of the Feasibility Study (FS) conducted to address contamination associated with Landfill 7 and Fire Protection Training Area 1 (FPTA1) within Zone D at F.E. Warren Air Force Base (FEW), Wyoming. Although no significant current risks were identified in the *Landfill 7 and FPTA1 Remedial Investigation* (RI) report (United States Air Force [USAF] 2002b), this document addresses the characteristics of the landfill as they may affect potential future risk. It then evaluates remedial alternatives that can be implemented to reduce infiltration and stabilize landfill wastes and impacted soils above the water table. This FS was conducted as described in the *Final Work Plan, Remedial Investigation/Feasibility Study for Zone D Source Areas* (USAF 2001). While the scope of the remedial actions under this FS includes groundwater associated with Landfill 7/FPTA1 as well as landfill wastes and soils, no significant current impact to groundwater associated with Landfill 7/FPTA1 was observed in the RI. The ultimate goals are to prevent Landfill 7/FPTA1 contaminants from causing potential future groundwater and surface water impacts and to limit human exposure to wastes and unexploded ordnance (UXO). Direct remediation of groundwater within Zone D, excluding groundwater associated with Landfill 7/FPTA1, is addressed under a separate groundwater RI/FS. To ensure completeness in content and develop consistency with other FEW FS reports, this report follows the format contained in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. Environmental Protection Agency [EPA] 1988).

Landfill 7 consists of two separate landfill cells, Landfill 7a and Landfill 7b. FPTA1 consists of three separate burn areas within and adjacent to Landfill 7b. Field observations suggest that the largest of these might have never been used for fire training. The landfill cells contain solid waste generated during base activities from the late 1930s through the early 1950s, mixed with soil and ash. Waste was burned prior to burial to reduce volume, and it is estimated that the composition is approximately 30 percent waste and 70 percent ash and burned residue. Waste was observed to be from one to eight feet thick, and 10 to 15 percent of the total waste volume is below the water table. Soil cover is thin or absent over portions of each landfill cell, and waste is exposed in an eroded stream bank at one location along Crow Creek.

The Remedial Action Objectives (RAO)s were developed based on 1) the potential for ponded storm water to cause excess infiltration and leaching of contaminants; 2) the potential for ground surface and stream channel erosion to expose additional waste or to transport contaminants and/or waste to Crow Creek; and 3) the potential for human contact with waste or UXO. The RAOs are to:

- Reduce potential leaching through the landfill materials by minimizing infiltration from stormwater that may pond on the landfill surface,
- Improve the long term stability of the landfill by controlling surface water run off and erosion from wind and water,
- Minimize contact with landfill materials that create a physical hazard to humans associated with waste materials, and
- Restoration of groundwater to beneficial use, which in this case is restoration of iron and manganese to background conditions. Background concentrations are best evaluated through future monitoring to address temporal and spatial variations. If iron and manganese associated with groundwater at Landfill 7 are established to be within background, there will be no further requirements for restoration.

Based on the RAOs and applicable or relevant and appropriate requirements (ARARs), general response actions were identified and technology types and process options were identified and screened. Five remedial alternatives were selected, developed and analyzed. Alternative 4 (Engineered Landfill Cap) is the presumptive remedy for CERCLA municipal landfill sites. The alternatives are:

- Alternative 1 - No Action,
- Alternative 2 - Institutional Controls,
- Alternative 3 - Limited Action (grading, soil cover, and revegetation),
- Alternative 4 - Engineered Landfill Cap, and
- Alternative 5 - Excavation and Removal.

Only Alternatives 2, 3, and 4 include 30 years of long-term monitoring (LTM), and Alternatives 3, 4, and 5 will also stabilize or remove wastes exposed in the Crow Creek stream bank. Each alternative was analyzed and assessed with respect to nine evaluation criteria. The first two criteria are threshold criteria. An alternative must meet both criteria before it can be considered

for a remedy. The next five criteria are balancing criteria, where the relative merits and tradeoffs among the criteria are evaluated. The final two are modifying criteria, in which the state and the community express whether they support or oppose the alternatives. The criteria are:

Threshold criteria:

- Overall protection of human health and environment
- Compliance with ARARs

Balancing criteria:

- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, or volume through treatment,
- Short-term effectiveness,
- Implementability; and
- Cost.

Modifying criteria:

- Agency acceptance, and
- Community acceptance.

A comparative analysis was performed to assess the relative performance of each alternative with respect to the first seven criteria.

Alternatives 1 and 2, No Action and Institutional Controls did not meet the threshold criterion of protectiveness because neither alternative addressed the potential for erosion or excess infiltration. Alternatives 3, 4, and 5 – Limited Action, Engineered Landfill Cap, and Excavation and Removal, respectively – all met both of the threshold criteria. Because Alternatives 1 and 2 did not meet the criterion for protectiveness, they were not carried through the rest of the comparative analysis.

Alternative 5 (Excavation/Removal) provides the best long-term effectiveness and permanence because waste and impacted soils are removed from the site. Alternative 5 also achieves the highest reliability and adequacy of controls. Alternatives 3 and 4 result in similar, low levels of residual risk. The reliability and adequacy of controls for Alternatives 3 and 4 are good.

Alternative 4 (Landfill Cap) requires long-term annual maintenance to maintain the integrity of the cap. Alternative 3 requires minimal long-term maintenance.

None of the alternatives reduce toxicity, mobility, or volume (TMV) through treatment. However, Alternative 5 effectively eliminates TMV at the site by removing the waste and soil to another location. Although both Alternatives 3 and 4 reduce contaminant mobility by reducing or eliminating infiltration, Alternative 4 is the more effective alternative, since the capping material proposed is impermeable.

Alternatives 3 and 4 would have minimal impacts on the community and workers because the remedial activities would be limited to the site and workers would experience only minimal exposure to landfill wastes and impacted soils. Increased truck traffic will have some short-duration impacts on the community. The greatest potential for short-term community, worker, and environmental impacts will be introduced during the implementation of Alternative 5, due to the large volume of material to be excavated, the relatively long duration of excavation activities, the need to excavate waste from the stream bank of Crow Creek, and the potential for impacting groundwater when removing waste from below the water table. Alternatives 3 and 4 will also require modifying the slope of the stream bank before riprap can be emplaced. In all cases, engineering controls and best management practices (BMPs) will be implemented to minimize potential impacts to the creek.

Alternative 5, excavation and disposal, has the longest remediation time at approximately eight months. Alternative 4 is the next shortest time at approximately two months. Alternative 3 has the shortest remediation time of approximately one month. All alternatives are implementable. Alternative 5 presents the most potential for delays or added costs due to potential UXO, waste handling, and disposal challenges.

Costs are summarized as follows:

Alternative	Capital Cost	Total O&M Cost	Net Present Value (5% discount)
3. Limited Action	$1,374,437	$1,165,849	$3,709,851
4. Engineered Landfill Cap	$3,817,993	$1,383,239	$6,632,387
5. Excavation and Removal	$8,061,079	$101,446	$8,285,761

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

This report documents the methods and findings of the Feasibility Study (FS) conducted to address waste remaining at Landfill 7 and Fire Protection Training Area 1 (FPTA1) within Zone D at F.E. Warren Air Force Base (FEW), Wyoming. Although no significant current risks were identified in the Landfill 7 and FPTA1 Remedial Investigation (RI) report (USAF 2002b), this document addresses the characteristics of the landfill as they may affect potential future risk. This FS report evaluates various remedial alternatives that can be implemented to stabilize landfill wastes and reduce potential future groundwater impacts. It was conducted as described in the *Final Work Plan, Remedial Investigation/Feasibility Study for Zone D Source Areas* (USAF 2001). This FS addresses contamination in landfill wastes, soils and groundwater impacted by Landfill 7/FPTA1. Based on the RI report, there are no significant current impacts to groundwater or surface water related to landfill materials, therefore this FS will only address potential future impacts to groundwater and surface water. Groundwater remediation within Zone D excluding Landfill 7/FPTA1 is addressed under a separate groundwater RI/FS.

To ensure completeness in content and develop consistency with other FEW FS reports, this report follows the format contained in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. Environmental Protection Agency [EPA] 1988). Based on that format, this FS report includes the following sections:

- Section 1.0—Introduction: Provides background information.
- Section 2.0—Identification and Screening of Technologies: Describes the processes that were used in identifying and evaluating possible alternatives.
- Section 3.0—Development and Screening of Alternatives: Describes the technologies that were identified and the evaluation of alternatives.
- Section 4.0—Detailed Analysis of Alternatives: Analyzes how well alternatives meet seven of the nine criteria provided in the EPA RI/FS guidance.
- Section 5.0—References: Lists the documents and publications used to generate this report.

1.2 BACKGROUND INFORMATION

The following subsections briefly describe the site history of FEW and the physical characteristics and the nature of contamination at Landfill 7.

1.2.1 Site Description

FEW is located on approximately 5,866 acres adjacent to the western city limits of Cheyenne, Wyoming. The facility is bordered by agricultural land, ranches, and residential areas of the city of Cheyenne and Laramie County. Most buildings, roads, and human activities are concentrated north of Crow creek in the areas adjacent to Randall Avenue.

Zone D is located in the southeastern portion of FEW, defined as the area south of Crow and Diamond Creeks, excluding Zone B and Zone C. The site descriptor "Landfill 7" had previously meant the general area on the relatively flat floodplain adjacent to and south of Crow Creek, between Old Glory Road and South Frontier Road (Figure 1-1). This FS uses the name in a similar context, i.e., to refer to a general geographic area. However, trenching has confirmed that Landfill 7 consists of two separate landfill cells, Landfill 7a and Landfill 7b. FPTA1 consists of three separate burn areas within and adjacent to Landfill 7b.

Low bluffs of Quaternary and Ogallala sediments are present immediately to the north of Crow Creek and adjacent to the Landfill 7/FPTA1 investigation area to the south (Figure1-2). The floodplain sediments beneath most of the Landfill 7/FPTA1 investigation area are coarse Quaternary alluvium deposited by Crow Creek, to a depth of approximately 25 feet below ground surface (bgs). The ground surface is hummocky.

Approximately 60 percent of Landfill 7a and 20 percent of Landfill 7b lie within the Crow Creek 100-year floodplain (Figure1-2), including an area of Landfill 7b that has less than 1 foot of soil cover over the waste. Landfills 7a, 7b, and FPTA1 are all located outside the delineated wetland areas.

The entire length of Crow Creek on FEW (the channel plus 394 feet on either side) has been proposed as Critical Habitat for the Preble's meadow jumping mouse. This area includes

approximately half of each of the landfill cells and all of the riparian area along Crow Creek (Figure 1-2). The heavy brush and tall herbaceous plants in the riparian area are favored by the mouse for cover, foraging, and breeding. The open grassy areas that cover the majority of the defined landfill cell footprints are used to a lesser extent for foraging.

1.2.2 Site History

The site background has been described in previous documents, including the 1991 *Installation Restoration Program (IRP) RI* (USAF 1991), the *Final Work Plan, Remedial Investigation/Feasibility Study for Zone D Source Areas, F.E. Warren Air Force Base, Cheyenne, Wyoming* (USAF 2001), and the *Landfill 7/FPTA 1 RI* (USAF 2002b). The site history included in these documents is briefly summarized below.

FEW was placed on the National Priorities List in February 1990. The FEW Installation Restoration Program (IRP) presently includes 20 sites. The sites are managed as 13 operable units (OUs) in 5 investigation zones (Zones A through E). Landfill 7 and FPTA1 are part of OU 10 and are in Zone D.

Landfill 7 in Zone D consists of two separate landfill cells: Landfill 7a and Landfill 7b. From an analysis of the artifacts recovered during RI trenching activities, it was determined that the two cells were used for Base landfill operations from the late 1930s through the early 1950s. The area was later used as an open-storage area for bulk materials (i.e., gravel and asphalt). Use of the Landfill 7a area for open storage of asphalt was reported as recently as 1994.

Between 1950 and 1965, several areas overlying Landfill 7b were used for fire training exercises. These areas comprise the site designated as FPTA1 and generally overlap with Landfill 7b. As a part of the training exercises conducted here, waste oils, solvents, gasoline, JP-4, and other combustible liquids were poured on the ground or on aircraft mock-ups, and ignited. A quantity of the fire retardant chlorobromomethane may also have been disposed on the ground surface near the former location of Building 344B (Figure 1-2). Although routine fire training activities were officially discontinued in 1965, subsequent fire training activities may have occurred after 1973 using recovered gasoline from Spill Site 1 (USAF 1991). Although the largest,

southernmost bermed area (Figure 1-2) was clearly designed for fire training, field observations and analytical results suggest that it may never have been used for that purpose.

1.2.3 Nature and Extent of Contamination

Because waste was burned periodically during landfill operations to reduce waste volume, identifiable waste encountered during the RI trenching activities mainly consisted of bottles, glassware, brick and metal construction materials, ceramics, leather, and other durable, non-combustible materials. In most cases, waste was mixed with ash, burn residue, and soil. During trenching, waste thicknesses of up to 8 feet were measured at Landfill 7a and up to 12 feet at Landfill 7b (Figure 1-3). Two unexploded anti-tank rockets were found in one trench at Landfill 7b. Based on observations during trenching, the materials in the landfill were estimated to be 70 percent ash and 30 percent waste.

Trenching was not permitted in the riparian zone adjacent to Crow Creek. However, waste has been observed in an eroded stream bank north of Landfill 7a. Because of the lack of subsurface data in this area, it is not certain if the observed waste is part of Landfill 7a, or if adequate soil cover exists. For estimating purposes, this FS assumes that waste is exposed in a maximum of 100 feet of stream bank, and that the exposed waste is an extension of Landfill 7a.

Hydrocarbon odors were sometimes detected in Landfill 7b where trenching coincided with the two smaller FPTA1 burn areas. Trace quantities of hydrocarbons were observed in the soil and as a sheen on the groundwater. Based on visual observations of apparent hydrocarbon staining in soils, four subsurface soil samples from the two smaller FPTA1 burn areas were analyzed for total petroleum hydrocarbons (TPH) by method SW8015 and volatile organic compounds by method SW8260B (which includes benzene, toluene, ethylbenzene and total xylenes [BTEX] constituents). The highest concentration reported was for diesel-range hydrocarbons at 414 mg/kg, or approximately 20 percent of the State Voluntary Remediation Program action level for TPH, which does not apply to FEW, but can be used as a guideline (Wyoming Department of Environmental Quality [WDEQ] 2001). Gasoline-range hydrocarbons were detected in only trace amounts.

Low and trace concentrations of trichloroethene (TCE) and trace concentrations of toluene, xylenes, and polycyclic aromatic hydrocarbons (PAHs) were also detected in soils associated with the two smaller FPTA1 burn areas.

In groundwater, only trace concentrations of toluene were detected (below the MCL), both upgradient and downgradient of Landfill 7. The other three BTEX constituents – benzene, ethylbenzene and total xylenes – were not detected in groundwater. There were no groundwater detections of TPH above the reporting limit at FPTA1 or downgradient from FPTA1. TCE was detected in groundwater both upgradient and downgradient of Landfill 7/FPTA1. However, the source of the TCE is attributed to upgradient Plume B. All groundwater in Zone D, except for groundwater potentially impacted by Landfill 7/FPTA1, is addressed in a separate groundwater RI/FS. The investigation at Landfill 7/FPTA1 identified no significant current groundwater impacts caused by Landfill 7/FPTA1, but the remedy will minimize the potential for future impacts.

Surface cover over the landfill cells ranges up to 5 feet in thickness, but may be thin or absent in places. Figure 1-4 shows areas where surface cover is less than 1 foot thick. Waste is also exposed where Crow Creek has eroded into the stream bank adjacent to Landfill 7a (Figure 1-2).

Because of the proximity of Crow Creek and the low relief adjacent to the creek, groundwater in Landfill 7/FPTA1 generally occurs between 2 and 10 feet bgs. An estimated 10 to 15 percent of the total waste volume is below the water table (Figure 1-5).

In the Landfill 7/FPTA1 RI, maximum contaminant detections were initially screened against EPA Region III Residential and Industrial risk-based concentrations (RBCs) and soil screening levels (SSLs). Compounds exceeding RBCs were further evaluated in the Baseline Risk Assessment (BRA), and compounds that exceeded the Region III SSLs were evaluated against site-specific SSLs to identify chemicals of concern (COCs). Exceedances of site-specific SSLs are summarized below.

Landfill 7a	No site-specific SSLs were exceeded in any of the 24 soil samples or 11 waste samples collected at Landfill 7a.
Landfill 7b/FPTA1	Of the 49 soil samples and 24 waste samples collected, the following site-specific SSLs were exceeded as follows (frequency in percent): • TCE (0.0754 mg/kg): 2 waste samples (8 percent) • benzo(a)anthracene (2.197 mg/kg): 1 waste sample (4 percent) • benzo(b)fluoranthene (6.790 mg/kg): 1 waste sample (4 percent) • 1,2,3,4,6,7,8-HpCDD (0.00084 mg/kg): 1 soil sample (2 percent) • 1,2,3,7,8-PeCDD (0.000017 mg/kg): 1 soil sample (2 percent) • total chromium (28.45 mg/kg): 1 waste sample (4 percent) • selenium (2.426 mg/kg): 3 waste samples (12 percent)
Intermediate Area	No waste was found in 4 of 4 trenches excavated in this area. No site-specific SSLs were exceeded in any of the 12 soil samples collected.
Downwind	No waste was found. A total of 10 surface soil samples were collected. No site-specific SSLs were exceeded in any of the 10 soil samples collected.

Most analytical results from waste samples were elevated when compared to results for the native surface and subsurface soil. Most compounds identified as potential leaching risks in soil and waste were not detected in groundwater downgradient from the landfill. Those compounds that were detected were reported at concentrations below background levels or at concentrations similar to or lower than those at upgradient wells (USAF 2002b). Exceptions were iron and manganese, which were detected at higher concentrations in some downgradient wells in comparison to upgradient wells.

No stained soil or odors were observed at the largest and southernmost bermed area of FPTA1. No semivolatile compounds or TPH were detected in soil samples from this area, although trace concentrations of toluene were reported in several subsurface soil samples. Low concentrations of TCE-related compounds and a single trace concentration of toluene were detected in groundwater samples from MW-087 and MW-096, both located within the footprint of the bermed area. No semivolatile compounds were detected in groundwater. Field observations suggested that the easily distinguishable bermed area may never have been used for fire training. This area will be excluded from remediation, except where surface grading is required to improve drainage over Landfill 7b.

1.2.4 Contaminant Fate and Transport

Contaminant fate and transport are discussed in detail in Section 5.0 and in Appendix I of the *Landfill 7 and FPTA1 RI* (USAF 2002b). Briefly, a quantitative evaluation of contaminant leachability was performed to determine the potential for contaminants of potential concern (COPCs) to impact groundwater. COPCs were identified by screening maximum concentrations of detected compounds against EPA Region III SSLs (dilution attenuation factor [DAF]=20) and, when appropriate, base-wide background concentrations. Concentrations of these COPCs were then compared to calculated site-specific soil screening levels to determine if they could potentially impact groundwater. Exceedances of site-specific SSLs are summarized in the previous section (Section 1.2.3).

1.2.4.1 Potential Routes of Migration

Because a slight upward vertical gradient exists in the vicinity of Landfill 7, impacts to deeper groundwater are less likely than possible impacts to the surface waters of Crow Creek. The principal route of contaminant migration from Landfill 7 to Crow Creek is leaching from soil or waste to shallow groundwater, and then lateral transport in shallow groundwater. Contaminants adsorbed to surface soil or exposed in waste at the surface could also be transported by surface runoff and potentially impact surface waters or surface sediments. Contaminants exposed at the surface could also be transported on wind-borne particles. Because of the low concentrations of TCE and the non-volatile nature of the other COCs, migration in a vapor phase is not significant.

1.2.4.2 Contaminant Persistence

The COCs identified in Section 1.2.3 are primarily high molecular weight hydrocarbons and metals. These compounds are relatively immobile and not susceptible to attenuating mechanisms such as biodegradation, volatilization, and chemical or biological stabilization. TCE, however, would be susceptible to these mechanisms, and concentrations would be expected to decrease over time as a result.

1.2.4.3 Degradation

The high concentrations of *cis*-1,2-DCE relative to TCE in the Landfill 7 groundwater indicate that degradation of TCE in groundwater is occurring by unknown reductive dechlorination mechanisms. Degradation of the high molecular weight organic contaminants in soil is probably also occurring, but would be a less significant attenuation mechanism for these compounds. Metals are not subject to degradation.

1.2.4.4 Adsorption

Adsorption is a significant mechanism affecting the mobility and migration of contaminants. The presence of carbon in both the flood plain sediments and in the ash and burned residue in the landfill may limit the mobility of the contaminants listed in Section 1.2.3.

1.2.5 Baseline Risk Assessment

Baseline human health risk assessments (HHRAs) and ecological risk assessments (ERAs) were conducted as part of the *Landfill 7 and FPTA1 RI* (USAF 2002b) to determine if soil conditions in Landfill 7 pose an unacceptable risk to human health or the environment.

1.2.5.1 Human Health Risk Assessment

Exposure Assessment Landfill 7 currently consists of open fields and abandoned unpaved roads. Although it is unlikely any of these areas would be developed for residential use in the future, that possibility could not be ruled out. Potential receptors identified for the Landfill 7 area were (1) future on-site child and adult recreational visitors, (2) current/future on-site adult occupational workers, and (3) construction workers assumed to work for short durations. In addition, a future hypothetical on-site residential scenario was evaluated for risk management purposes to identify whether institutional controls are needed or, if there is a change in land use, whether a remedy may need to be re-evaluated. The exposure pathways evaluated for all receptors were incidental ingestion of soil, dermal contact with soil, and inhalation of fugitive dusts.

Human Health Risk Characterization. For surface soil, thallium was the only COPC with a toxicity value. For all receptors exposed to surface soil, the central tendency exposure (CTE) and reasonable maximum exposure (RME) total hazard indices (HIs) were below the target HI of 1. Cancer risks were not estimated for these receptors because there were no carcinogenic COPCs. There were no COPCs for surface/subsurface soil combined. The results of the baseline HHRA indicate that soils and waste at Landfill 7 do not pose an unacceptable risk to human health.

1.2.5.2 Ecological Risk Assessment

Exposure Assessment Ecological receptors chosen for the ERA included the horned lark (avian herbivore), western meadowlark (avian omnivore), deer mouse (small mammalian omnivore), and soil invertebrates. These receptors were evaluated for exposure to chemicals in surface soil only. Exposure routes included direct soil ingestion and dietary ingestion for the bird and mammal receptors and direct soil contact for soil invertebrates. Terrestrial plants were evaluated for exposure by direct contact with chemicals in both surface soil (0 to 2 feet bgs) and shallow subsurface soil (0 to 5 feet bgs). Details of this process are presented in Appendix J of the *Landfill 7 and FPTA1 RI* (USAF 2002b).

Ecological Risk Characterization COPECs retained for quantitative risk assessment from the initial RBC screening were evaluated according to the hazardous quotient (HQ) method. The exposure point concentration (EPC), which represents the minimum of either the maximum or UCL95 soil concentration, was compared to a chemical-specific lowest observable adverse effect level (LOAEL) toxicity reference value (TRV) for birds or mammals as appropriate. Because of the effect of uncertainties associated with key risk components on overall risk estimation, ecological risk is categorized based on the following HQ ranges (Menzie et al. 1992):

- HQs less than 1 - No risk
- HQs between 1 and 10 - Low potential for adverse effects
- HQs between 10 and 100 - Low to moderate potential for adverse effects
- HQs greater than 100 - Expected adverse effects

Compounds with HQs greater than 100 would normally be identified as COCs, and remedial alternatives would be evaluated for impacted soils.

The ERA indicated a potential for low to moderate adverse ecological effects to small mammals from selenium (HQ=30), and low risks to avian species from exposure to antimony, barium, selenium, thallium, and TCE in surface soils (HQs≤10). No apparent risks to soil invertebrates were identified for any contaminants of potential ecological concern (COPECs) in surface soil (HQs<1). Low risks were identified for plants exposed to selenium in surface soils and lead in shallow subsurface soil.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

This section presents the remedial action objectives (RAOs) for waste materials and soils at Landfill 7/FPTA1. RAOs are site-specific initial cleanup objectives that have been developed based on the nature and extent of contamination and the potential for human and environmental impacts. The RAOs provide the basis for selecting appropriate response actions and remedial technologies and for developing alternatives. Groundwater impacts caused by Landfill 7/FPTA1 are within the scope of this FS, but no significant current impacts were observed in the RI. The RAOs will however prevent future potential groundwater impacts. Therefore, there are no RAOs specifically to address current groundwater conditions. Although remedial actions will primarily address landfill wastes and soils, the ultimate goal is to protect groundwater and surface water from leaching or runoff of Landfill 7/FPTA1 contaminants.

Technologies and process options are developed based on those general responses and screened on the basis of effectiveness, implementability, and cost. The result of this screening process is a small set of viable remedial responses that represent a wider range of remedial actions. This set of alternatives will be further analyzed in Sections 3 and 4.

2.2 REMEDIAL ACTION OBJECTIVES

2.2.1 Remedial Action Objectives

RAOs are medium-specific goals for protecting human health and the environment that assist in the development and evaluation of remedial action alternatives. The following RAOs have been developed for Landfill 7/FPTA1 based on 1) the potential for ponded storm water to cause excess infiltration and leaching of contaminants; 2) the potential for ground surface and stream channel erosion to expose additional waste or to transport contaminants and/or waste to Crow Creek; and 3) the potential for human contact with UXO.

- Reduce potential leaching through the landfill materials by minimizing infiltration from stormwater that may pond on the landfill surface,
- Improve the long term stability of the landfill by controlling surface water run off and erosion from wind and water,
- Minimize contact with landfill materials that create a physical hazard to humans associated with waste materials, and
- Restoration of groundwater to beneficial use, which in this case is restoration of iron and manganese to background conditions. Background concentrations are best evaluated through future monitoring to address temporal and spatial variations. If iron and manganese associated with groundwater at Landfill 7 are established to be within background, there will be no further requirements for restoration.

Based upon the findings of the *Landfill 7/FPTA1 RI*, groundwater is not currentlyimpacted by landfill wastes or FPTA1-impacted soils (USAF 2002b). Therefore, numeric remediation goals are not defined in this FS. The implementation of the alternatives evaluated will prevent future groundwater impacts. The effectiveness of the alternatives will be measured by their potential to prevent future impacts to groundwater above the numeric drinking water criteria referenced in the Zone D Groundwater Feasibility Study, and in the Wyoming Water Quality Rules and Regulations.

2.2.2 Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d)(2)(A) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) specifies that on-site remedial actions be evaluated to determine if they meet standards, requirements, criteria, or limitations under any Federal environmental law that is determined to be an ARAR. This provision also specifies that State ARARs must be met if they are more stringent than Federal requirements. Federal, State, and local regulations, requirements, criteria, and limitations were evaluated to determine if they are potentially applicable or relevant and appropriate to the screened alternatives in this FS. A regulation, standard, requirement, criterion, or limitation under Federal or State law may be either applicable or relevant and appropriate to a remedial action. Criteria, advisories, and guidelines that are not law may be used to provide guidance in the absence of ARARs or when ARARs are not sufficient to protect human health and the environment.

The screening of remedial response actions at Landfill 7 may incorporate environmental policies, guidance or proposals that are not applicable or relevant and appropriate, but do address specific concerns. Such to-be-considered (TBC) standards may be used in determining clean up levels necessary for the protection of human health and the environment. The following TBC standards were screened: *Wyoming Interim Cleanup Objectives for Total Petroleum Hydrocarbons in Soil and Groundwater* (WDEQ 2001).

ARARs are typically divided into three categories: 1) those that pertain to the management of certain chemicals; 2) those that control specific actions; and 3) those that restrict certain activities at a given location. Chemical-specific ARARs are typically numerical [risked based] values or methodologies that establish limits on the concentrations of a chemical that may be discharged or found in the environment and be detrimental to human health and environmental quality. Action-specific ARARs are technology- or activity-based requirements and limitations on actions taken involving the management of hazardous wastes. Location-specific ARARs are restrictions placed on the conduct of activities in unique or sensitive areas to prevent damage in that area.

ARARs and TBCs were developed using the following guidelines and documents:

- *CERCLA Compliance with Other Laws Manual, Part I: Interim Final* (US EPA 1988);
- *CERCLA Compliance with Other Laws Manual, Part II: Clean Water Act and Other Environmental Statutes and State Requirements* (US EPA 1989);
- *Superfund Removal Procedures: Guidance on the Consideration of ARARs During Removal Actions* (US EPA 1991);
- *RCRA, Superfund & Emergency Planning and Community Right-to-Know Act (EPCRA) Hotline Training Module: Introduction to Applicable or Relevant and Appropriate Requirements* (US EPA 1998).

2.2.2.1 Potential Applicable or Relevant and Appropriate Requirements

2.2.2.1.1 Chemical-Specific ARARS

The potential chemical-specific Federal ARARs identified in Table 2–1 are the following:

- Federal Safe Drinking Water Act (42 United States Code [USC] Section 300) - Establishes drinking water standards to protect public health by limiting levels of contaminants.
- The Clean Air Act (42 USC 7401–7642) – Establishes ambient air standards to protect public health by limiting levels of contaminants.

The potential chemical-specific State ARARs identified in Table 2-1 are the following:

- Wyoming Solid Waste Management Rules and Regulations – Lists analytes and approved analytical methods for both detection and assessment monitoring.
- Wyoming Water Quality Rules and Regulations – Establishes surface and groundwater standards to protect public health and environmental quality.
- The Wyoming Air Quality Standards and Regulations – Establishes ambient air standards and substantive requirements to protect public health by limiting levels of contaminants.

2.2.2.1.2 Action-Specific ARARs

Potential action-specific Federal ARARs include the following:

- Clean Air Act (42 United States Code [USC] 7401) — Establishes air quality standards to protect public health and the environment. Includes National Emissions Standards for Hazardous Air Pollutants (40 Code of Federal Regulations [CFR], Part 61, Subpart A) and National Primary and Secondary Ambient Air Quality Standards and Emissions.
- Clean Water Act (33 USC 1251) — Establishes requirements for permits to authorize the discharge of dredged or fill material into navigable waters of the United States, addresses wetlands and alterations to stream courses (Section 404 permit), and identifies storm water management requirements under the National Pollutant Discharge Elimination System (NPDES).
- Resource Conservation and Recovery Act (RCRA) (42 USC 6901-6992) — Gives the EPA the authority to regulate hazardous waste from “cradle to grave.” This includes the generation, characterization, transportation, treatment, storage, and disposal of hazardous waste. RCRA also sets forth a framework for the management of non-hazardous wastes. Wyoming has an authorized state level RCRA program for the management of hazardous and non-hazardous waste (see the WSWMRR and WHWRR below).

- Endangered Species Act. 16 USC, Section 1531; 50 CFR, Parts 17 and 402. Requires that federal activities not jeopardize the continued existence of any threatened or endangered species. Specifically requires that Federal entities consult with the US Fish and Wildlife Service prior to commencing activities, which may adversely affect a Preble's meadow jumping mouse (*Zapus hudsonius prebei)* population.

Potential action-specific state ARARs include the following:

- Wyoming Solid Waste Management Rules and Regulations (WSWMRR) — General provisions, definitions, and regulations for the permitting, operation, monitoring and closure of sanitary landfills and other types of solid waste handling facilities. The Wyoming Environmental Quality Act (WEQA) authorizes in W.S. 35-11-503 the promulgation of the Wyoming Solid Waste Management Rules and Regulations (WSWMRR) by adopting rules and regulations that are consistent with and equivalent to the Resource Conservation and Recovery Act (RCRA). Thus, the WSWMRR has primacy over RCRA in the state of Wyoming.

- Wyoming Environmental Quality Act — In addition to listed actions in chemical-specific ARARs, the act also provides for the protection of the State's resources for beneficial use, in addition to the protection of public health.

- Wyoming Water Quality Rules and Regulations (WWQRR) — Provides requirements for testing procedures, establishes human health values for surface water.

- Wyoming Air Quality Standards and Regulations — Identifies standards for air emissions from specific sources and types of contaminants.

- Wyoming Hazardous Waste Rules and Regulations (WHWRR) — Identifies and lists hazardous waste and provides standards for hazardous waste generators, transporters, owners, and operators of hazardous waste treatment, storage, and disposal facilities. The Wyoming Environmental Quality Act (WEQA) authorizes in W.S. 35-11-503 the promulgation of the Wyoming Hazardous Waste Rules and Regulations (WHWRR) by adopting rules and regulations that are consistent with and equivalent to the Resource Conservation and Recovery Act (RCRA). Thus, the WHWRR has primacy over RCRA in the state of Wyoming.

The concentrations of contaminants detected in trench and borehole samples of Landfill 7 waste indicate that most, if not all, would be characterized as nonhazardous waste. Any hazardous waste encountered during the remedial action will be managed according to the WHWRR requirements.

Action-specific Federal and State ARARs are described in more detail in Table 2-2 and are further analyzed in Section 4.

2.2.2.1.3 Location-Specific ARARs

The potential location-specific Federal ARARs may include some of the same Federal statutes listed as action-specific ARARs, as well as the Endangered Species Act of 1973 (ESA) (16 USC 1531) (50 CFR Part 402). The ESA requires, in part, that the impacts on endangered and threatened species and their habitats be considered during any remedial actions. The specific ESA designation of "Critical Habitat" along Crow Creek in July 2002 places certain protections on riparian and upland areas within 394 feet of the channel. Most significantly, the designation requires the Air Force to consult with the U.S. Fish and Wildlife Service before conducting any activities that might affect the habitat.

Potential location-specific State ARARs include the WWQRR, which provides standards for protection of wetlands and classification of streams, and the Wyoming Solid Waste Management Rules and Regulations, which regulate the siting of sanitary landfills and other types of solid waste handling facilities. Location-specific Federal and State ARARs are described in more detail in Table 2-3 and are further analyzed in Section 4. A chemical-specific to be considered criterion was evaluated and presented in Table 2-5.

2.2.2.1.4 Potential Wyoming Relevant and Appropriate Requirements

Because the operation and closure of Landfill 7 predates the authorization and promulgation of State regulations that guide the operation of sanitary landfills, these regulations are generally not applicable to Landfill 7. However, some sections may be relevant and/or appropriate to consider in evaluating remedial alternatives for landfill waste and impacted soils. Potential relevant and appropriate State requirements were identified in Chapters 1, 2, and 15 of the Wyoming Solid Waste Management Rules and Regulations, which regulate the location, permitting, construction, operation, monitoring, and closure of sanitary landfills. These requirements are listed and described in Table 2-4, and analyzed in Section 4.

2.3 GENERAL RESPONSE ACTIONS

General response actions are medium-specific response categories that will satisfy the RAOs. The general response actions developed for Landfill 7/FPTA1 are presented in Table 2-6.

2.4 IDENTIFYING AND SCREENING TECHNOLOGY TYPES AND PROCESS OPTIONS

The purpose of this section is to identify and screen remedial technologies and process options that will meet the RAOs defined in Section 2.2.

2.4.1 Identification and Screening of Technologies

Remedial technologies are the methods by which the general response actions in Table 2-6 may be applied. Process options are the specific processes within a technology type by which the technology may be implemented. Once the technology types and process options are identified, they are evaluated on the basis of technical implementability, without considering effectiveness or cost. Table 2-7 gives the results of this technical implementability evaluation. The technology types and process options identified for screening were:

- No action
- Access restrictions (as institutional controls)
- In-situ remediation technologies such as capping, stabilization, and other limited actions
- Ex-situ remediation technologies such as excavation and removal

It should be noted that the technology types and process options included in the tables are not an exhaustive list, but rather represent a range of remedial technologies and configurations for the identified general response actions that are relevant to this site.

2.4.2 Evaluation of Technologies and Selection of Representative Technologies

The next stage in the alternative development is evaluation of the retained technology processes so that one process option can be selected to represent the entire class of a technology type in the subsequent portions of the analysis. This evaluation uses the criteria of effectiveness, implementability, and cost to select the most promising remedial alternative within a technology type. Evaluations are based on engineering judgment, and the process options are scored on a "high, medium, and low" scale relative to other options within their technology type. The results of this process option evaluation are given in Table 2-8. It should be noted that for technology types with only one process option (i.e., no action and institutional control), the effectiveness,

implementability, and cost scorings represent a relative comparison between technology types. For these technology types, the sole process option identified was retained for analysis.

Based on the evaluation, the process options retained for assembly into alternatives for Landfill 7 are:

- No Action
- Institutional Controls
- Limited Action (including grading, stream bank stabilization, and soil cover)
- Engineered Landfill Cap
- Excavation and Removal

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section develops the alternatives for Landfill 7 soil and waste remediation from the technologies and process options that were retained in Section 2.4.

3.1 DEVELOPMENT OF ALTERNATIVES

3.1.1 Alternative 1 – No Action

Alternative 1 consists of leaving Landfill 7 soils and waste in their current condition. Waste and impacted soils are left in their current location, and access to and use of the area would not be further restricted.

3.1.2 Alternative 2 – Institutional Controls

Alternative 2 consists of physical and/or administrative controls to limit access and development at Landfill 7/FPTA1. The LF7 area will be permanently identified as a landfill area, which will need to be maintained for the foreseeable future. Access to the area will be controlled and activities inconsistent with the operation and maintenance of the landfill prohibited. Under this alternative, waste and impacted soils will be left in their current location.

LTM will be performed as part of Alternative 2 at the following five upgradient and five downgradient wells:

	Upgradient	**Downgradient**
Landfill 7a	MW-072 MW-291	LF7MW02 MW-127
Landfill 7b/FPTA1	MW-086 MW-091 MW-093	LF7MW03 MW-289 MW-293

For costing purposes, it is proposed that groundwater be monitored quarterly for 3 years following implementation of this alternative, followed by 5 years of semiannual monitoring and then 22 years of annual monitoring. Samples will be analyzed for volatile organic compounds (VOCs), metals, and field parameters.

The goal of the LTM will be to establish baseline concentrations upgradient and downgradient from the landfill cells, and to detect contaminants that may leach from waste in the future.

The accumulated groundwater data will be reviewed annually to determine whether the frequency and duration are appropriate to achieve the LTM goals. All aspects of the long-term monitoring will be reviewed during the 5-year review of the Record of Decision (ROD) for Landfill 7/FPTA1. Surface water in Crow Creek will not be monitored as part of the Landfill 7/FPTA1 LTM, but will be monitored as part of the FEW basewide LTM.

3.1.3 Alternative 3 – Limited Action

Alternative 3 consists of limited remedial actions for the soils and waste material at Landfill 7. Limited Action will consist of (1) adding a 1-foot minimum cover over waste where less than 1 foot of cover currently exists; (2) re-grading the two landfill cells to eliminate ponding, reduce localized infiltration, reduce erosion, and promote drainage; (3) establishing vegetation over the landfills that will inhibit erosion and provide plant respiration to reduce infiltration; (4) stabilizing stream banks along Crow Creek to prevent erosion of waste materials; (5) well abandonment; and (6) implementing institutional controls to limit access and development of the site. Figure 3-1 shows the Limited Action alternative for Landfill 7.

The cover will consist of approximately 38,000 cubic yards (CY) of clean fill material and topsoil (minimum 6 inches of topsoil). The landfill cells will be graded to reduce ponding and localized infiltration of meteoric water, reduce erosion, and promote drainage. In no case will the existing cover be graded to less than 1 (one) foot thick over the landfill waste. All disturbed areas will be revegetated.

The stream bank adjacent to Landfill 7a will be stabilized to prevent the erosion of waste materials exposed in the stream bank. This task assumes a 5-foot vertical bank, 100 feet long, with waste exposed along the entire length, but no waste below the water line. An access road will be created to reach the bank, but equipment will not be required to cross or enter the stream channel. The slope of the bank will be laid back to approximately 40 degrees from horizontal. The new slope will be covered with 1 foot of clean fill, followed by a geotextile and

approximately 50 CY of 25 to 500-pound rock riprap. Disturbed areas will be revegetated with native brushes, grasses, and tall herbaceous species to restore the current thick brushy habitat favored by the Preble's meadow jumping mouse. Any disturbed upland areas will be revegetated with native prairie species.

Any clean soil removed during excavation will be replaced as part of the stream bank cover, or stockpiled and used for landfill cover material. Because the extent of waste in this area is not known, it is assumed for costing purposes that all excavated material will be disposed of offsite as non-hazardous material.

It is estimated that grading and soil placement will require the abandonment of seven wells. The affected wells at Landfill 7a are MW-053, MW-128, and MW-290. The affected wells at Landfill 7b/FPTA1 are MW-092, MW-094, MW-095, and MW-096. For costing purposes, 25-foot 2-inch polyvinyl chloride (PVC) wells were assumed.

Physical and/or administrative controls to limit access and development at Landfill 7/FPTA1, as discussed in Section 3.1.2 will be implemented as part of the overall limited action remedy. Groundwater will be monitored for 30 years as described in Section 3.1.2. Because existing groundwater data indicate no significant current impacts to downgradient groundwater, the goal of the LTM will be to ensure that the existing data are representative of year-round conditions, and that concentrations of contaminants in downgradient groundwater do not increase over time.

3.1.4 Alternative 4 – Engineered Landfill Cap

Capping is the EPA's presumptive remedy for municipal landfills. Alternative 4 consists of the installation of an engineered cap typical of RCRA Subtitle D landfill facilities containing non-hazardous wastes. The cells will be filled and graded for drainage, and to provide a minimum of 2 feet of soil between the waste and the liner. For costing purposes, an impermeable liner of 40-mil thickness high-density polyethylene (HDPE) is proposed, followed by a geonet/geotextile layer to prevent erosion on the HDPE surface. This will be overlain by a minimum of 2 feet of clean soil, 6 inches of topsoil, and shallow-rooting vegetation. A total of 73,000 CY of clean fill

and topsoil were estimated. Institutional controls will be implemented to limit access and development of the Landfill 7/FPTA1 site.

A drain system will be installed along the north-northeast border of the landfill cells to collect storm water runoff flowing off the impermeable cap. Any runoff that is collected will be directed into Crow Creek. The impermeable cap will effectively eliminate the infiltration of meteoric water through the landfill cells and prohibit any erosion of landfill materials or impacted soils. This alternative differs from Alternative 3 in that its intent is to eliminate any leachate formation, rather than reducing infiltration and leachate by reducing ponding, improving drainage, and encouraging vegetative respiration. Figure 3-2 shows the Engineered Landfill Cap alternative for Landfill 7.

The stream bank adjacent to Landfill 7a will be stabilized to prevent the erosion of waste materials exposed in the stream bank, as described in Section 3.1.3.. However, vegetation planted on the Engineered Landfill Cap must consist of shallow-rooting species that will not compromise the impermeable layer. For this reason, where the Landfill Cap extends into former riparian areas, riparian vegetation similar to the existing vegetation cannot be planted after cap installation. Vegetation for Alternative 4 will consist of native and non-native shallow-rooting species. This will result in the permanent loss of a small area of riparian habitat used by the Preble's meadow jumping mouse for cover and breeding.

Physical and/or administrative controls to limit access and development at Landfill 7/FPTA1, as discussed in Section 3.1.2 will be implemented as part of the overall limited action remedy. Groundwater will be monitored for 30 years as described in Section 3.1.2. Because existing groundwater data indicate no significant current impacts to downgradient groundwater, the goal of the LTM will be to ensure that the existing data are representative of year-round conditions, and that concentrations of contaminants in downgradient groundwater do not increase over time.

It is estimated that grading, excavation, and cap construction will require the abandonment of the seven monitoring wells described in Section 3.1.3.

3.1.5 Alternative 5 – Excavation and Removal

Alternative 5 consists of excavating all landfill contents above and below the water table, segregating, if necessary, and hauling the material to appropriate disposal facilities, and backfilling the excavation with clean fill material. For costing purposes, it is assumed that all material excavated will be non-hazardous, and that it will be disposed at an offsite location within 50 miles of the base. The North Weld Landfill near Ault, Colorado is approximately 40 miles south of the base. However, if available space and other considerations allow it, the FEW Waste Consolidation Area (WCA) could also be utilized for some or all of the excavated material. It is assumed that seven existing monitoring wells will be abandoned prior to excavation (Section 3.1.3.).

An estimated 175,000 loose cubic yards (LCY) of material will be removed and hauled offsite over an 8-month period. Approximately 200,000 LCY of clean fill will be used to fill the excavations and establish a final grade. Approximately 4,560 LCY of topsoil will be placed at a minimum thickness of 6 inches. All disturbed areas will be revegetated using native species. Revegetation in the riparian zone will consist of seeding and planting of native brushes, grasses, and tall herbaceous species to restore the current thick brushy habitat favored by the Preble's meadow jumping mouse. Upland areas will be revegetated with native prairie species.

This alternative entails several technical challenges. First, an estimated 10 to 15 percent of the total waste volume is below the calculated mean groundwater level. Because of the highly conductive nature of the shallow aquifer (pebbly, gravelly, few fines) and the proximity of Crow Creek, it will not be feasible to dewater the waste before removing it. Waste in the saturated zone will be targeted for removal when the water table is at a seasonal low. Additionally, disturbing waste in the saturated zone could have a negative impact on groundwater quality. Second, UXO was observed during trenching, and likely occurs in the rest of the landfill. Plans for waste removal will include procedures to minimize exposure to UXO and to handle and dispose of UXO, if necessary. Third, if waste in the stream bank occurs below the water line, a cofferdam or other control may be required to minimize turbidity in the creek. Figure 3-3 shows the Excavation and Disposal alternative for Landfill 7.

This alternative also includes stabilization of the stream bank adjacent to Landfill 7a to prevent the erosion of waste materials exposed in the stream bank, as described in Section 3.1.3. Because Alternative 5 will excavate wastes in the stream bank, the final slope and grade will depend on how much waste is present (investigative trenching did not take place in riparian areas, so extent of waste in the riparian area adjacent to Landfill 7a is not known). If waste is present below the Crow Creek water level, channel control measures such as cofferdams may be required to limit turbidities in Crow Creek.

Because waste will be removed, and will significantly reduce potential future groundwater impacts, institutional controls to limit access and development of the Landfill 7/FPTA1 area will not be implemented as part of Alternative 5. No LTM will occur, however, the stream bank will be inspected periodically to ensure that it has been permanently stabilized.

3.2 SCREENING OF ALTERNATIVES

Five alternatives have been developed to address contamination at Landfill 7. These alternatives range from no action to excavation and removal. Therefore, it is not necessary to screen out any of the alternatives to reduce the number of alternatives that will be analyzed in detail. All of the alternatives will be carried forward to the Detailed Analysis of Alternatives in Section 4.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

The nine criteria listed in the National Oil and Hazardous Substances Contingency Plan (40 CFR Part 300) that must be considered in the detailed analysis of alternatives are:

- Overall protection of human health and environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State agency acceptance
- Community acceptance

The first two criteria, Overall Protection of Human Health and Environment and Compliance with ARARs, are threshold criteria. These criteria must be met before an alternative can be considered a remedy. The next five criteria — Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility, or Volume Through Treatment; Short-term Effectiveness; Implementability; and Cost — are balancing criteria, where the relative merits and tradeoffs among different alternatives may be evaluated. The remaining two criteria, State Agency Acceptance and Community Acceptance, are modifying criteria and will be addressed in the ROD after agency and public comments have been received. Table 4-1 summarizes the detailed alternatives analysis for Landfill 7/FPTA1. Following the individual analysis is a comparative analysis of the alternatives. The comparative analysis assesses the relative performance of each alternative with respect to each criterion.

4.1.1 Overall Protection of Human Health and Environment

This criterion provides an assessment of how well an alternative protects human health and the environment. This overall assessment is based on the assessment of other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Evaluation of this criterion focuses on whether an alternative achieves adequate protection and describes how risks posed through each pathway are managed by the alternative. This evaluation also considers whether an alternative poses any unacceptable short-term or cross-medium impacts.

4.1.2 Compliance with ARARs

This criterion is used to evaluate whether an alternative will meet the requirements which are applicable or relevant and appropriate as identified in Section 2.2.2. Tables 4-2, 4-3, 4-4 and 4-5 provide an analysis of ARARs and evaluate how the alternatives will or will not meet the requirements.

4.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence are evaluated in terms of the risk remaining at the site after implementation of an alternative. The two components of this criterion are the magnitude of residual risk at the conclusion of the remedial action and the adequacy and reliability of controls.

4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion reflects statutory preference for remedial actions that permanently and significantly reduce toxicity, mobility, and/or volume of contaminants through treatment technologies. This preference is satisfied when treatment is used to destroy toxic contaminants, irreversibly reduce contaminant mobility, or reduce the total volume of contaminated media. Even though none of the alternatives employ active treatment, reductions achieved by the alternatives will be evaluated against this criterion because the resulting mobility and volume will vary among the alternatives.

4.1.5 Short-Term Effectiveness

This criterion addresses the effects of an alternative during the construction and implementation phase. Specifically, short-term effectiveness includes an evaluation of the ability of an alternative to protect workers and the community during the remedial action, the environmental

and natural resource impacts of construction and implementation, as well as how the remedy reduces injury to existing natural resources. In addition, this criterion evaluates the time until remedial action objectives are met.

4.1.6 Implementability

Implementability refers to the technical and administrative feasibility of an alternative, along with the availability of services and materials. Evaluation of technical feasibility considers the ease of construction and operation, the reliability of the technology, and the ease of undertaking additional actions, if required. Administrative feasibility considers the coordination with other offices and agencies for permit applications, etc.

4.1.7 Cost

The cost criterion has two primary components: capital costs and O&M costs. Capital costs include both direct costs (e.g., construction, equipment, and disposal costs) and indirect costs (e.g., engineering, licensing, and start-up costs). O&M costs refer to post-construction costs required to ensure the continuing effectiveness of the remedial action.

To allow comparison of costs incurred in different years, the cost analysis includes a net present value (NPV) analysis for each alternative. For the NPV analysis, future costs are discounted to the current year using a discount rate of 5 percent after inflation.

4.1.8 State Agency Acceptance

This criterion evaluates the technical and administrative preferences and issues that the State of Wyoming may have regarding each alternative. State acceptance is not addressed in this FS but will be addressed in the ROD after agency review.

4.1.9 Community Acceptance

This criterion assesses the issues and concerns the public may have regarding each of the alternatives. As with State acceptance, this criterion will be addressed in the ROD based on public comments and is not evaluated in the FS.

4.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

This section of the FS provides a detailed analysis of each alternative for remediation of Landfill 7 relative to the first seven of the nine criteria described in the previous section. Table 4-1 summarizes the detailed alternatives analysis for Landfill 7.

4.2.1 Alternative 1—No Action

Alternative 1 is the No Action alternative, which includes no remedial elements. The No Action alternative is described in Section 3.1.1.

4.2.1.1 Overall Protection of Human Health and Environment

This alternative is not protective of human health and the environment.

4.2.1.2 Compliance With ARARS

Because landfill operations ceased before current regulations were developed, and because the No Action alternative does not involve any construction, removal, or monitoring activities, potential ARARs are limited to the Wyoming Water Quality Rules and Regulations, which set standards for groundwater quality. This ARAR could apply to potentially leaching of landfill waste material.

4.2.1.3 Long-Term Effectiveness and Permanence

The No Action alternative does not actively remove or treat contamination. Therefore, the only changes in the magnitude of residual contamination stem from natural attenuation processes. Since the alternative does not involve treatment, containment, or removal, there is a potential that future risks might increase due to erosion of landfill materials or increased infiltration. This alternative is considered to have low long-term effectiveness and permanence.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will not reduce the toxicity, mobility, or volume of contaminants, although these characteristics may be reduced by natural attenuation processes. Because natural attenuation processes have been acting on landfill contaminants for over 40 years, and because most of the

identified COCs have low mobility, it is expected that additional reductions achieved by natural attenuation processes would be slight.

4.2.1.5 Short-Term Effectiveness

The No Action alternative does not include soil treatment or controls. Because no remedial action is taken, there is no additional potential for short-term exposure to the community or workers. There are no ecological or natural resource impacts associated with implementation of this alternative.

4.2.1.6 Implementability

This alternative is easily implemented, and no special technical challenges are associated with the alternative.

4.2.1.7 Cost

The estimated costs for the No Action alternative include no O&M costs and no capital costs. Long-term monitoring will not be conducted as part of this alternative.

4.2.2 Alternative 2—Institutional Controls

4.2.2.1 Overall Protection of Human Health and Environment

Although this alternative restricts human access to waste and UXO that could potentially be exposed in the future, it does not provide protection of groundwater or surface water resources through stabilization of the landfill or reduction of infiltration. It does not meet this threshold criterion.

4.2.2.2 Compliance With ARARs

Because landfill operations ceased before current regulations were developed, and because the Institutional Controls alternative does not involve any construction or removal activities, potential ARARs are limited to those related to long-term groundwater monitoring. Potential ARARs include: the Wyoming Water Quality Rules and Regulations, which set standards for groundwater quality; the Wyoming Solid Waste Management Rules and Regulations, which

require post-closure groundwater monitoring at landfills; and the Wyoming Environmental Quality Act and the Wyoming Hazardous Waste Management Rules and Regulations, which would regulate the handling and disposal of any hazardous IDW generated during groundwater monitoring.

These requirements will be met by using state groundwater quality standards to evaluate LTM results, and by handling any hazardous IDW generated during LTM according to state regulations.

4.2.2.3 Long-Term Effectiveness and Permanence

The alternative only limits direct human exposure to waste and UXO that could potentially be exposed in the future. Since the alternative does not involve treatment, containment, or removal, there is a potential that future risks might increase due to erosion of landfill materials or increased infiltration. This alternative would not meet the RAO.

4.2.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will not reduce the toxicity, mobility, or volume of contaminants, although these characteristics may be reduced by natural attenuation processes. Because natural attenuation processes have been acting on landfill contaminants for over 40 years, and because most of the identified COCs have low mobility to begin with, it is expected that additional reductions achieved by natural attenuation processes would be slight.

4.2.2.5 Short-Term Effectiveness

There is no potential for short-term impacts to the community. Workers will be protected during any site activities via proper site controls and personal protective equipment (PPE). There are no ecological or natural resource impacts associated with the implementation of this alternative.

4.2.2.6 Implementability

This alternative is easily implemented, and no special technical challenges are associated with it.

4.2.2.7 Cost

The estimated costs for the Institutional Controls alternative include $10,893 in capital cost and a total O&M cost of $755,769. Annual O&M costs are $69,188 for the first three years, $32,993 for years 4 through 8, and $17,420 for years 9 through 30. O&M costs include three years of quarterly monitoring, five years of semiannual monitoring and 22 years of annual monitoring as described in Section 3.1.1. The NPV is $1,431,071 using a 5 percent discount factor after inflation. Appendix A presents cost estimation reports for this alternative.

4.2.3 Alternative 3—Limited Action

Alternative 3 consists of limited actions at the site, including placement of soils to achieve a minimum 1-foot cover, grading to ensure proper drainage and to prevent ponding and erosion, stream bank stabilization, and revegetation.

4.2.3.1 Overall Protection of Human Health and Environment

This alternative protects human health and the environment by reducing the potential for landfill waste and UXO to pose a future risk to human health and the environment. A vegetated soil cover will reduce erosion and will reduce infiltration through plant respiration. Grading will reduce infiltration by eliminating ponding and promoting drainage, and will reduce erosion. Stream bank stabilization will eliminate the potential for waste to be eroded by Crow Creek.

4.2.3.2 Compliance With ARARs

The Limited Action alternative will comply with all ARARs. This will be achieved mainly through the use of BMPs.

Run-on and run-off controls such as silt fencing, control berms and hay bales will be utilized to minimize surface water runoff into Crow Creek from the remedial area. Fugitive dust will be minimized by BMPs such as tarping/covering soil piles and the wetting of soils. While the implementation of this alternative will involve mobile point sources of air emissions, emissions will be far below the ambient air quality standards. Field monitoring will be performed to ensure

air quality is maintained with respect to VOCs. A Best Available Control Technology will be implemented if necessary, although it is not expected to be required.

Grading and revegetation will be implemented to reduce erosion and ponding of the final cover. Access to the site during closure and revegetation will be restricted by the installation of a security fence. All personnel will have current OSHA 40-hour HAZWOPER training. Groundwater will be monitored in five upgradient and five downgradient monitoring wells: quarterly for 3 years, followed by 5 years of semiannual monitoring and then 22 years of annual monitoring.

Hazardous waste generation is possible in this alternative in the form of IDW from the groundwater monitoring if the purge water is characteristically hazardous. If IDW is determined to be hazardous, it will be properly packaged, labeled, manifested and transported to an appropriate, properly permitted facility for treatment and disposal. Trucks hauling hazardous waste will be properly placarded and will follow all applicable Department of Transportation regulations regarding the transportation of hazardous waste.

4.2.3.3 Long-Term Effectiveness and Permanence

The residual potential for future risk following implementation of this alternative will be low. Once the alternative has been implemented and a vegetative cover established, the reliability of the control is high. Minor maintenance might be required following extreme precipitation events. The adequacy is moderate when compared to an engineered landfill cap.

4.2.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Contaminant mobility will be decreased by reducing infiltration and erosion. Contaminant toxicity and volume will be reduced only by natural attenuation processes.

4.2.3.5 Short-Term Effectiveness

Short-term negative effects as a result of grading, filling, and stream bank stabilization will be minimal.

Protection of the Community. The implementation of Alternative 3 will have a minimal impact on the community. Remedial activities will be conducted in an unoccupied field with limited access, thereby minimizing exposure risk to military and civilian personnel working at or visiting the base. Potential receptors include workers and visitors using buildings north of Crow Creek, the closest of which is approximately 300 feet north of Landfill 7a, at its closest point. More numerous are visitors, customers, and employees at the base BX and related businesses south of Missile Drive. The BX is approximately 700 feet from the closest boundary of Landfill 7a. A Burger King restaurant, which receives considerably less traffic, is approximately 300 feet from the closest boundary of Landfill 7a.

The potential short-term impacts of Alternative 3 on the community will be fugitive dust emissions from grading and filling activities, and the increased truck traffic required to haul approximately 38,000 CY of clean fill and topsoil to the site. It is not anticipated that any hazardous materials will be excavated or hauled from the landfill during grading or stream bank stabilization. Noise from grading, filling, and the increased traffic will not be at hazardous levels, but might be considered a nuisance.

Fugitive dust control will be utilized as needed. Truck traffic will be routed through the base's south gate to minimize the impacts to the more densely occupied areas to the north of Crow Creek. Finally, the short duration of the remedial activities (4 weeks) will also minimize the cumulative effects of impacts that might occur.

Protection of Workers. The majority of the site work will require use of standard heavy construction equipment. During site operations, all applicable safety precautions will be carried out to protect workers from potential physical hazards. Engineering controls, monitoring, and PPE will be used during site operations. Physical hazards during site operations are the primary hazards associated with this alternative. Because intrusive activities are limited to modifying the slope of the stream bank, there is minimal risk of encountering UXO during remediation. All site workers shall have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and 8-hour annual refresher courses as specified in 29 CFR 1910.120.

Short-Term Environmental Impacts. The removal of existing vegetation to accommodate grading and filling activities will result in the temporary loss of riparian habitat along Crow Creek, and foraging and grazing habitat in upland areas. Stabilizing the Crow Creek stream bank will result in the permanent alteration of up to 100 feet of stream bank. Erosion during remediation or revegetation of the landfill cells or the stream bank could potentially cause short-term increases of turbidity in Crow Creek.

Engineering controls and BMPs will be implemented to minimize the impacts to Crow Creek during stream bank stabilization and the filling, grading, and revegetation of all areas. These measures might include run-on/run-off control berms or swales, filter barriers, or hay bales. Work on the stream bank of Crow Creek and in the riparian zone will be undertaken between November 30 and March 15 to take advantage of seasonal low creek flow and to minimize impacts to fish spawning and the Preble's meadow jumping mouse. Revegetation in the riparian zone will consist of seeding and planting of native brushes, grasses, and tall herbaceous species to restore the current thick brushy habitat favored by the Preble's meadow jumping mouse. Upland areas will be revegetated with native prairie species.

Time Until Response Objectives are Achieved. Site activities including soil cover placement, grading, stream bank stabilization, and re-vegetation are anticipated to take approximately 4 weeks. Assuming response objectives will be achieved when vegetation is fully established, it is anticipated that response objectives will be met within approximately 2 years. Annual monitoring will be required under this alternative, and watering of the vegetative cover may be required initially.

4.2.3.6 Implementability

The Implementability of Alternative 3 is evaluated as follows:

Technical Feasibility. No unusual procedures will be used in the implementation of Alternative 3, and readily available material, labor, and equipment will be utilized to perform all site work. Grading, erosion control, and stream stabilization will require a minor engineering effort.

Administrative Feasibility. Although permits are not required for stream bank stabilization or the other elements of Alternative 3, the substantive requirements of the Clean Water Act and the Clean Air Act will be followed, and all remedial action will be coordinated with WDEQ prior to implementation. All work potentially impacting Crow Creek will comply with NPDES storm water regulations and applicable State requirements, and will also be coordinated with WDEQ. As provided in Section 7 of the Endangered Species Act, the USAF will consult with the U. S. Fish and Wildlife Service to ensure that impacts to Preble's meadow jumping mouse habitat are minimized. Since 60 to 70 percent of the Landfill 7/FPTA1 area (Figure 1-2) has been proposed as Critical Habitat, this consultation will occur prior to detailed planning of this alternative.

No structures requiring building permits will be constructed as part of this alternative. No easements or right-of-way acquisitions are required on USAF-owned and controlled property; however, various utilities run through the site. If intrusive activities should encroach on utility placements, utilities will be relocated or otherwise isolated during field operations. No adjacent or adjoining properties will be impacted by Alternative 3.

Institutional controls will be implemented to control development and access at the site, protect the integrity of the cover material, and limit erosion.

State and Community Acceptance. State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final FS to the regulatory agencies. A Responsiveness Summary will be prepared to address all significant public comments received and to discuss impacts on the FS and proposed remedy for Landfill 7.

4.2.3.7 Cost

The estimated costs for the Limited Action alternative include $1,374,437 in capital cost and total O&M costs of $1,165,849. Annual O&M costs are approximately $82,029 during the first three years, $46,474 in years 4 through 8, and $31,191 in years 9 through 30. O&M costs include 3 years of quarterly groundwater monitoring followed by 5 years of semiannual monitoring and 22 years of annual monitoring. In addition to monitoring, maintenance of the

landfill cover will be performed for a 30-year period. Maintenance will include, but is not limited to, reseeding, regrading, watering, and landscaping. For costing purposes, it is assumed that maintenance will be performed annually, but actual O&M shall be performed as required by site conditions. The NPV is $3,709,851 using a 5 percent discount factor after inflation. Appendix B presents cost estimation reports for this alternative.

4.2.4 Alternative 4—Engineered Landfill Cap

Alternative 4 consists of installing an impermeable cap over the Landfill 7 area, along with stream bank stabilization. Grading and re-vegetation are a component of cap construction.

4.2.4.1 Overall Protection of Human Health and Environment

This alternative protects human health and the environment by reducing the potential for landfill waste to pose a future risk to human health and the environment. Meteoric water will be intercepted by the cap or respirated by the vegetative cover, and will not come in contact with landfill material, eliminating leachate formation in the vadose zone.

4.2.4.2 Compliance With ARARs

This alternative will comply with the ARARs listed in Tables 4-2 to 4-5.

Run-on and run-off controls, such as silt fencing, control berms and hay bales will be utilized to minimize surface water runoff into Crow Creek from the remedial area. Additionally, a drain system will be installed along the north-northeast border of the landfill cells to collect storm water runoff flowing off the impermeable cap. Any runoff that is collected will be directed into Crow Creek. At no time will the run-off be in contact with the landfill waste or impacted soils. The impermeable cap will effectively eliminate the infiltration of meteoric water through the landfill cells and prohibit any erosion of landfill materials or impacted soils.

Fugitive dust will be minimized by BMPs such as tarping/covering soil piles and the wetting of soils. While the implementation of this alternative will utilize mobile point sources of air emissions, emissions will be far below the ambient air quality standards. Field monitoring will be performed to ensure air quality is maintained with respect to VOCs. A Best Available Control

Technology will be implemented if necessary, although it is not expected to be required. All personnel will be appropriately trained with current OSHA 40-hour HAZWOPER certifications.

Seven existing monitoring wells will be abandoned according to Wyoming regulations prior to grading of the site. Institutional controls will be implemented to limit access to the site during closure and revegetation (and following implementation of this alternative). Hazardous waste generation is possible in this alternative in the form of IDW from the groundwater monitoring if the purge water is characteristically hazardous. If IDW is determined to be hazardous, it will be properly packaged, labeled, manifested and transported to an appropriate, properly permitted facility for treatment and disposal. Trucks hauling hazardous waste will be properly placarded and will follow all applicable Department of Transportation regulations regarding the transportation of hazardous waste.

4.2.4.3 Long-Term Effectiveness and Permanence

The residual potential for future risk following implementation of this alternative will be low. The reliability of the technology is high, although engineered landfill caps normally require regular long-term maintenance. The measure is the most effective method of eliminating infiltration through landfills.

4.2.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative does not reduce contaminant toxicity or volume. Volatile contaminant mobility in the vadose zone would be reduced, and non-volatile contaminants would become effectively immobile.

4.2.4.5 Short-Term Effectiveness

Short-term negative effects as a result of cap construction and stream bank stabilization will be minimal.

Protection of the Community. The implementation of Alternative 4 will have a minimal impact on the community. Remedial activities will be conducted in an unoccupied field with limited access, thereby minimizing exposure risk to military and civilian personnel working at or

visiting the base. Potential receptors include workers and visitors using buildings north of Crow Creek, the closest of which is approximately 300 feet north of Landfill 7a, at its closest point. More numerous are visitors, customers, and employees at the base BX and related businesses south of Missile Drive. The BX is approximately 700 feet from the closest boundary of Landfill 7a. A Burger King restaurant, which receives considerably less traffic, is approximately 300 feet from the closest boundary of Landfill 7a.

The potential short-term impacts of Alternative 4 on the community will be fugitive dust emissions from grading and filling activities, and the increased truck traffic required to haul approximately 68,000 CY of clean fill and topsoil to the site. It is not anticipated that any hazardous materials will be excavated or hauled from the landfill during grading or stream bank stabilization. Noise from grading, filling, and the increased traffic will not be at hazardous levels, but might be considered a nuisance.

Fugitive dust control will be utilized as needed. Truck traffic will be routed through the base's south gate to minimize the impacts to the more densely occupied areas to the north of Crow creek. Finally, the relatively short duration of the remedial activities (8 to 10 weeks) will also minimize the cumulative effects of whatever impacts that might occur.

Protection of Workers. The cap installation will require the use of heavy equipment. Workers implementing the removal action will have minimal contact with the contaminated materials. Engineering controls, monitoring, and PPE will be used during the removal action to minimize potential worker exposure. The primary risks to workers are fugitive dust, chemical vapors, and physical hazards associated with heavy equipment operation and cap placement. Because intrusive activities are limited to modifying the slope of the stream bank, there is minimal risk of encountering UXO during remediation.

Dust suppression will be required to reduce inhalation exposures. It is not anticipated that any workers will enter any excavations, but if site conditions require entry, workers shall follow all excavation and confined space safety guidelines including benching, sloping, and shoring. These potential risks will be minimized by using Occupational Safety and Health Administration

(OSHA)-trained crews and appropriate controls that are standard at hazardous waste and construction sites. All workers shall have 40-hour HAZWOPER training and the 8-hour annual refresher courses as specified in 29 CFR 1910.120.

Short-Term Environmental Impacts. The removal of existing vegetation to accommodate grading, filling, and cap construction will result in the permanent loss of riparian habitat along Crow Creek, and the alteration of foraging and grazing habitat in upland areas. Stabilizing the Crow Creek stream bank will result in the permanent alteration of up to 100 feet of stream bank. Erosion during remediation or revegetation of the landfill cells or the stream bank could potentially cause short-term increases of turbidity in Crow Creek.

Engineering controls and best management practices will be implemented to minimize the impacts to Crow Creek during stream bank stabilization and the filling, grading, and revegetation of all areas. These measures might include run-on/run-off control berms or swales, filter barriers, or hay bales. Work on the stream bank of Crow Creek and in the riparian zone will be undertaken between November 30 and March 15 to take advantage of seasonal low creek flow and to minimize impacts to fish spawning and the Preble's meadow jumping mouse.

Vegetation planted on the Engineered Landfill Cap must consist of shallow-rooting species that will not compromise the HDPE layer or the GCL. For this reason, where the Landfill Cap extends into former riparian areas, riparian vegetation similar to the existing vegetation cannot be planted after cap installation. Vegetation for Alternative 4 will consist of native and non-native shallow-rooting species. This will result in the permanent loss of a small area of riparian habitat used by the Preble's meadow jumping mouse for cover and breeding.

Time Until Response Objectives are Achieved. It is anticipated that mobilization, grading, cap placement, cover, re-vegetation, site restoration, and demobilization will require approximately 8 to 10 weeks. The estimated landfill area to be capped is 12.68 acres. Stream bank stabilization activities will coincide with removal activities.

4.2.4.6 Implementability

Technical Feasibility. Alternative 4 is technically feasible for Landfill 7. The implementation of this alternative employs proven equipment and techniques. Because the landfill contents have had up to 45 years to reach a physical equilibrium, settling and compaction will not have a significant effect on cap design. The combination of an impermeable layer, soil and vegetative cover has been shown to be effective in preventing water infiltration in other implementations. Cap design and stream bank stabilization will require a minor engineering effort.

Administrative Feasibility. Although permits are not required for stream bank stabilization or the other elements of Alternative 4, the substantive requirements of the Clean Water Act and the Clean Air Act will be followed, and all remedial action will be coordinated with WDEQ prior to implementation. All work potentially impacting Crow Creek will comply with NPDES storm water regulations and applicable State requirements, and will also be coordinated with WDEQ. As provided in Section 7 of the Endangered Species Act, the USAF will consult with the U. S. Fish and Wildlife Service to ensure that impacts to Preble's meadow jumping mouse habitat are minimized. Since 60 to 70 percent of the Landfill 7/FPTA1 area (Figure 1-2) has been proposed as Critical Habitat, this consultation will occur prior to detailed planning of this alternative.

No structures requiring building permits will be constructed as part of this alternative. No easements or right-of-way acquisitions are required on USAF-owned and controlled property; however, various utilities run through the site. If intrusive activities should encroach on utility placements, utilities will be relocated or otherwise isolated during field operations. No adjacent or adjoining properties will be impacted by Alternative 4.

Institutional controls will be implemented to control development and access at the site and to protect the integrity of the cap.

Availability of Services and Materials. The equipment necessary to complete this alternative, heavy earth-moving and material-handling equipment, is commonly available. The materials required for capping, stream bank stabilization, grading, and re-vegetation are readily available from local or regional vendors.

State and Community Acceptance. State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final FS to the regulatory agencies. A Responsiveness Summary will be prepared to address all significant public comments received and to discuss impacts on the FS and proposed remedy for Landfill 7.

4.2.4.7 Cost

The estimated costs for an engineered landfill cap and associated tasks at Landfill 7 include $3,817,993 in capital costs and $1,383,239 in total O&M costs. Annual O&M costs are $89,315 during the first three years, $53,760 in years 4 through 8, and $38,477 in years 9 through 30. Capital costs include cap installation and activities related to the initial field effort. O&M costs include 3 years of quarterly groundwater monitoring followed by 5 years of semiannual monitoring and 22 years of annual monitoring. In addition to groundwater monitoring, regular cap maintenance is included in the cost estimate for a period of 30 years. Regular cap maintenance includes reseeding, regrading, watering, and general landscaping, plus repair of the liner if damaged or exposed. For costing purposes, it is assumed that cap maintenance will be performed annually, but actual maintenance may vary as required by site conditions. The NPV cost for implementation of an engineered landfill cap is $6,632,387. Cost estimation reports are found in Appendix C.

4.2.5 Alternative 5—Excavation and Off-site Disposal

Alternative 5 consists of excavating Landfill 7 and disposing of the material in an appropriate landfill facility. For costing purposes, it is assumed that material will be all non-hazardous, and will be hauled to a facility within 50 miles of FEW. The North Weld Landfill near Ault, Colorado was previously used for disposal of landfill materials from FEW, a distance of approximately 40 miles. However, if available space and other considerations allow it, the FEW WCA could also be utilized for some or all of the excavated material. The excavations will be backfilled with approximately 200,000 CY of clean fill material imported from an off-site location.

4.2.5.1 Overall Protection of Human Health and Environment

This alternative protects human health and the environment by eliminating the potential for landfill waste to pose a future risk to human health and the environment. Because the contaminated surface and subsurface materials will be removed and replaced with clean fill, erosion and infiltration may occur without creating a potential future risk. However, the filled excavation will be graded and revegetated to minimize erosion of soils into Crow Creek.

4.2.5.2 Compliance With ARARs

The Excavation and Disposal alternative will comply with the ARARs listed in Tables 4-2 to 4-5.

During the excavation, run-on and run-off controls, such as silt fencing, control berms and hay bales will be utilized to minimize surface water runoff into Crow Creek from the remedial area. The removal of landfill waste and impacted soil from the landfill cells will effectively eliminate the issue of groundwater leaching.

BMPs such as tarping/covering soil piles and the wetting of soils will minimize fugitive dust during the excavation and backfilling. While the implementation of this alternative will utilize mobile point sources of air emissions, emissions will be far below the ambient air quality standards. Field monitoring will be performed to ensure air quality is maintained with respect to VOCs. A Best Available Control Technology will be implemented if necessary, although it is not expected.

After excavation, clean fill material and topsoil will be backfilled, graded and revegetated to prevent pooling, ponding and erosion. All disturbed areas will be revegetated using native species. Revegetation in the riparian zone will consist of seeding and planting of native brushes, grasses, and tall herbaceous species to restore the current thick brushy habitat favored by the Preble's meadow jumping mouse. Upland areas will be revegetated with native prairie species.

Seven existing monitoring wells will be properly abandoned prior to grading of the site. Access to the site during excavation and revegetation will be controlled. All personnel will have current OSHA 40-hour HAZWOPER certification.

Hazardous waste could potentially be generated in this alternative in the form of excavated materials. Excavated soil and waste will be characterized using toxicity characteristic leaching procedure (TCLP) analysis and will be managed as a hazardous waste if it is determined to be characteristically hazardous. After characterization, the contaminated soil and waste will be packaged and labeled, if necessary, and placed onto trucks for disposal, within the 90-day accumulation period. The trucks will be tarped to prevent soil and debris from contaminating the haul route. Trucks hauling hazardous waste will be properly placarded and will follow all applicable Department of Transportation regulations regarding the transportation of hazardous waste. A manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the transporter to track and provide a record of the quantity of excavated soil. A decontamination pad will be constructed at the truck exit to remove residual soil from dump truck tires to avoid contaminating nearby roadways. All hazardous waste will be transported to an appropriate, properly permitted facility for treatment and disposal. If dewatering is necessary during the excavation activities, the collected water will be analyzed and managed appropriately.

4.2.5.3 Long-Term Effectiveness and Permanence

Alternative 5 will achieve long-term effectiveness by removing landfill waste and impacted soil. Excavation and removal is the most common form of soil remediation, and placement in a secure facility will isolate the contaminated media from any contact with potential receptors. No long-term adverse impacts are anticipated for this alternative.

4.2.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although no treatment will be conducted, contaminant toxicity and volume at the site would be reduced by removing waste to an approved facility. The mobility of the contaminants will be reduced by placing the soil in a properly constructed landfill facility.

4.2.5.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 5 is evaluated as follows:

Protection of the Community. The implementation of Alternative 5 will have a moderate impact on the community, due primarily to the large volumes of waste and soil to be hauled from the site, and the large volume of clean fill and topsoil to be brought in. Although remedial activities will be conducted in an unoccupied field with limited access, the duration of remedial activities will increase the possibility of impacts to military and civilian personnel working at or visiting the base. Potential receptors include workers and visitors using buildings north of Crow Creek, the closest of which is approximately 300 feet north of Landfill 7a, at its closest point. More numerous are visitors, customers, and employees at the base BX and related businesses south of Missile Drive. The BX is approximately 700 feet from the closest boundary of Landfill 7a. A Burger King restaurant, which receives less traffic, is approximately 300 feet from the closest boundary of Landfill 7a. A significant volume of truck traffic will be generated during removal and filling of the excavation. This traffic would most likely use FEW's southern gate, which is adjacent to Interstate Highway 25 and provides highway access to the North Weld Landfill, a regional landfill near Ault, Colorado (approximately 40 miles south).

The potential short-term impacts of Alternative 5 on the community will be fugitive dust emissions from grading and filling activities, and the increased truck traffic required to haul approximately 175,000 LCY of waste and soil from the site, and to haul approximately 204,000 LCY of clean fill and topsoil to fill and establish a grade on the landfill. It is not anticipated that any hazardous materials will be excavated or hauled from the landfill during grading or stream bank stabilization. Noise from excavating, filling, and grading and the increased traffic will not be at hazardous levels, but might be considered a nuisance. Odors associated with excavation and hauling of landfill materials may also be objectionable. The large volume of heavy truck traffic could cause FEW roads along the haul route to deteriorate and/or require additional maintenance.

Fugitive dust control will be utilized as needed. Truck traffic will be routed through the base's south gate to minimize the impacts to the more densely occupied areas to the north of Crow creek. However, because of the long duration of the project, the cumulative effects of these impacts could be significant.

Protection of Workers. The excavation will require the use of heavy equipment. Workers implementing the removal action will have minimal contact with the contaminated materials. Engineering controls, monitoring, and PPE will be used during the removal action to minimize potential worker exposure. The primary risks to workers are fugitive dust, chemical vapors, and physical hazards associated with heavy equipment operation and excavation. In addition, UXO was encountered during previous intrusive activities, and would probably be encountered during remediation.

Dust suppression will be required to reduce inhalation exposures. It is not anticipated that any workers will enter the excavation, but if site conditions require entry, workers shall follow all excavation and confined space safety guidelines including benching, sloping, and shoring. These potential risks will be minimized by using OSHA-trained crews and appropriate controls that are standard at hazardous waste and construction sites. Excavation procedures will provide for the probability of encountering UXO, and plans will include procedures for handling and disposing of UXO.

Short-Term Environmental Impacts. The removal of existing vegetation prior to excavation will result in the temporary loss of riparian habitat along Crow Creek, and foraging and grazing habitat in upland areas. Parts of Landfill 7/FPTA1 have been proposed as Critical Habitat under the Endangered Species Act, and riparian zones are particularly important. Work in the riparian zone will be expedited to minimize the impacts to the Preble's meadow jumping mouse. Although the work would likely progress in phases elsewhere in Landfill 7/FPTA1, some areas could remain without vegetation during the entire duration of this alternative, increasing the risks of erosion. Stabilization of the Crow Creek stream bank will result in the permanent alteration of up to 100 feet of stream bank. Erosion during excavation or revegetation of the stream bank or the landfill cells could potentially cause short-term increases of turbidity in Crow Creek.

space exists on-site to create separate stockpiles should material other than those characterized for disposal be encountered.

Administrative Feasibility. Although permits are not required for stream bank stabilization or the other elements of Alternative 5, the substantive requirements of the Clean Water Act and the Clean Air Act will be followed, and all remedial action will be coordinated with WDEQ prior to implementation. All work potentially impacting Crow Creek will comply with NPDES storm water regulations and applicable State requirements, and will also be coordinated with WDEQ. As provided in Section 7 of the Endangered Species Act, the USAF will consult with the U. S. Fish and Wildlife Service to ensure that impacts to Preble's meadow jumping mouse habitat are minimized. Since 60 to 70 percent of the Landfill 7/FPTA1 area (Figure 1-2) has been proposed as Critical Habitat, this consultation will occur prior to detailed planning of this alternative. Coordination with FEW facilities personnel may be required to evaluate the impact of large volumes of heavy truck traffic on FEW roads.

No structures requiring building permits will be constructed as part of this alternative. No easements or right-of-way acquisitions are required on USAF-owned and controlled property; however, various utilities run through the site. If intrusive activities should encroach on utility placements, utilities will be relocated or otherwise isolated during field operations.

Institutional controls will be implemented to control access to the site during revegetation.

Availability of Services and Materials. The equipment necessary to complete this alternative, heavy earth-moving equipment, is commonly available. Additionally, all materials required for backfilling, stream bank stabilization, site restoration, and re-vegetation are readily available from local vendors.

TCLP testing is a standard requirement for most commercial disposal facilities, and these analytical services are available from a large number of commercial laboratories. In addition to the possibility of additional waste characterization sampling, confirmation sampling will be conducted upon completion of the excavation to ensure that the lateral excavation was sufficient. No specialized testing services are required under this alternative.

State and Community Acceptance. State and community acceptance will be determined based on comments received during the public comment period. A 30-day public comment period will follow submittal of the Final FS to the regulatory agencies. A Responsiveness Summary will be prepared to address all significant public comments received and to discuss impacts on the FS and proposed remedy for Landfill 7.

4.2.5.7 Cost

The estimated costs for the excavation and removal of the Landfill 7 waste material and associated tasks include $8,061,079 in capital cost and $101,446 in total O&M costs. Annual O&M costs are $3,368 during the first year, and $3,382 in years 2 through 30. O&M costs include monitoring of the streambank to ensure that excessive erosion does not occur. This alternative does not include long-term groundwater monitoring as part of the remedy. Thirty years of maintenance, including watering and landscaping, are also included in the O&M costs to ensure that vegetation is established during site restoration. The Alternative 5 estimate includes assumptions that the material will be hauled to an off-site disposal facility and that all backfill material will be imported from an off-site source. Using a 5 percent discount factor over the projected life of the project (30 years), the NPV cost for this alternative is $8,285.761. Appendix D presents cost estimation reports for this alternative.

4.3 COMPARATIVE ANALYSIS OF TECHNOLOGIES

This section compares alternatives for Landfill 7/FPTA1, as opposed to the previous section that compared each alternative to the seven criteria independently. The comparative analysis presents each criterion and discusses how well the alternatives meet that criterion. The results of the comparative analysis are presented in Table 4-6.

4.3.1 Overall Protection of Human Health and Environment

Alternative 3 meets this threshold criterion by reducing ponding and the resulting excess localized infiltration, stabilizing waste in the Crow Creek stream bank, reducing erosion through grading and vegetation, and limiting potential human contact with wastes and UXO through institutional controls and by the addition of one foot of soil cover.

Alternative 4 meets this threshold criterion by construction of an engineered landfill cap and stabilization of waste in the Crow Creek stream bank. The cap will be graded to encourage drainage, and will incorporate an impermeable layer that will eliminate infiltration. The alternative eliminates the potential for human contact with wastes and UXO through institutional controls and by the addition of an engineered landfill cap as described in Section 3.1.4.

Alternative 5 meets this threshold criterion by removing waste and impacted soils, making erosion of waste and infiltration irrelevant.

Alternatives 1 and 2 do not meet this threshold criterion because they do not address landfill stability or infiltration, although Alternative 2 (Institutional Controls) does limit human contact with waste and any UXO that might be exposed in the future. Because Alternatives 1 and 2 do not meet this threshold criterion, they will not be included in the rest of the comparative analysis of alternatives.

4.3.2 Compliance with ARARs

Alternatives 3, 4 and 5 comply with their respective action-specific ARARs (Table 4-3). Each alternative also takes actions that will reduce or eliminate the potential impacts of Landfill 7 due to its design and siting, thus addressing potential chemical- and location-specific ARARs (Table 4-2, Table 4-4, and Table 4-5, respectively). Alternative 4 will have the highest number of ARARs to meet.

4.3.3 Long-Term Effectiveness and Permanence

Alternative 5 (Excavation/Removal) provides the best long-term effectiveness and permanence because waste and impacted soils will be removed from the site. Alternatives 3 and 4 result in similar, low levels of residual risk because both stabilize the landfill materials against erosion, and reduce (Alternative 3) or eliminate (Alternative 4) localized infiltration.

The highest reliability and adequacy of controls is achieved by Alternative 5. The reliability and adequacy of controls for Alternatives 3 and 4 are good. Alternative 4 (Engineered Landfill Cap) is the presumptive remedy for CERCLA sanitary landfill sites. Alternatives 3 and 4 require a

similar amount of O&M to establish and maintain vegetation and to monitor and repair erosion. In addition to establishing vegetation and repairing erosion, the Engineered Landfill Cap will require long-term maintenance to maintain the integrity of the cap and liner. Alternative 5 requires negligible O&M in the form of streambank inspection to ensure minimal erosion.

4.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

None of the alternatives reduce toxicity, mobility, or volume (TMV) through treatment. However, Alternatives 3, 4, and 5 reduce mobility by containment. The most effective TMV reductions are achieved by Alternative 5, which removes the waste from the site. Alternative 4 uses an impermeable barrier to eliminate infiltration, and more effectively reduces the likelihood of leachate formation and migration than Alternative 3. Alternative 3 reduces contaminant mobility by reducing localized infiltration, thus reducing the likelihood of leachate formation and migration.

4.3.5 Short-Term Effectiveness

Alternatives 3 and 4 would have minimal impacts on the community and workers because the remedial activities would be limited to the site and workers would experience only minimal exposure to landfill wastes and impacted soils. For Alternatives 3 and 4, some heavy truck traffic would be associated with hauling fill and topsoil to the site, about twice as much for the Engineered Landfill Cap as for the Limited Action. Potential impacts from the increased traffic would be moderated somewhat by the relatively short durations of these two alternatives. In Alternative 5, a large volume of heavy truck traffic over a relatively long period of time could potentially impact the military personnel, visitors, customers, and employees at the businesses south of Landfill 7/FPTA1 and along the haul route, although the most likely route is not densely populated.

Workers implementing Alternative 5 will be excavating, handling, and transporting landfill materials, introducing a potential for exposure. Additional UXO will likely be excavated, and waste not characterized during trenching could be encountered. However, all active alternatives

will utilize the proper PPE and safety procedures to minimize worker contact with waste, impacted soils, and UXO.

The greatest potential for environmental impacts will be introduced during the implementation of Alternative 5, because of the large volume of material to be excavated, the relatively long duration of excavation activities, and the need to excavate waste from the stream bank of Crow Creek. Additionally, removal of waste from below the water table could have a negative impact on groundwater quality. The next most significant impact is from the Engineered Landfill Cap, which results in the permanent loss of riparian vegetation along Crow Creek in addition to stream bank slope modification and riprap placement. Alternatives 3 and 5 also require riprap placement, but the remaining disturbed areas along Crow Creek can be revegetated with riparian vegetation. In all cases, engineering controls and BMPs will be implemented to minimize potential impacts to the creek.

Of the active methods, Alternative 3 has the shortest remediation time of approximately 4 weeks. Alternative 4 is the next shortest time at 8 to 10 weeks. Alternative 5, excavation and disposal, has the longest remediation time at approximately 8 months.

4.3.6 Implementability

These alternatives can be implemented without significance administrative or technical challenges. Alternative 3 is the least complex and most easily implemented alternative involving active remediation. Implementing Alternatives 4 and 5 require additional engineering and technical expertise, and are more difficult to implement. Alternative 5 presents the most challenges due primarily to waste handling and disposal. Specifically, encountering additional UXO or other waste not characterized during trenching could delay remediation or add cost, and removing waste in the saturated zone will present technical challenges.

4.3.7 Cost

Costs are summarized as follows:

Alternative	Capital Cost	Total O&M Cost	Net Present Value (5% discount)
3. Limited Action	$1,374,437	$1,165,849	$3,709,851
4. Engineered Landfill Cap	$3,817,993	$1,383,239	$6,632,387
5. Excavation and Removal	$8,061,079	$101,446	$8,285,761

5.0 REFERENCES

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TABLES

TABLE 2-1
POTENTIAL CHEMICAL-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate[1]	Comments
Federal				
Federal Safe Drinking Water Act	42 USC Section 300	Establishes drinking water standards to protect public health by limiting levels of contaminants	No/No	Not applicable or relevant and appropriate, however soil screening levels (SSLs) for landfill contaminants were calculated based on drinking water MCLs.
State of Wyoming				
Wyoming Solid Waste Management Rules and Regulations	Appendices A and B	Lists analytical methods to be used for monitoring sanitary landfills.	No/*see Table 2-4*	*see Table 2-4*
Wyoming Water Quality Rules and Regulations	Chapter I, Appendix B	Lists surface water quality criteria	No/No	Only applicable or relevant and appropriate in the event of a discharge of materials to Crow Creek.
	Chapter VIII, Table 1	Lists numeric groundwater quality standards	**Yes**/--	Applicable due to the possibility of constituents leaching into the groundwater. Standards for iron and manganese are primary standards under Chapter VIII, which are secondary standards under the federal rules
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	**Yes**/--	Applicable since some activities, such as excavation, have the potential to release chemical specific emissions

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = applicable or relevant and appropriate requirements
MCL = Maximum Contaminant Level
TBC = to-be-considered
USC = United States Code

TABLE 2-2
POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation(s)	Description	Applicable/ Relevant and Appropriate[1]	Comments
Federal				
Clean Water Act	33 USC Section 1251–1376	Establishes requirements for regulating discharge of pollutants in waters.	No/No	Substantive requirements apply.
	33 USC Sections 401, 404	Establishes requirements for making alterations to stream courses	**Yes**/--	Substantive requirements apply.
Endangered Species Act	16 USC, Section 1531; 50 CFR, Parts 17 and 402	Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	**Yes**/--	Areas to be remediated are in proposed Critical Habitat of the Preble's meadow jumping mouse (*Zapus hudsonius preblei).* The USAF will consult with the US Fish and Wildlife Service prior to implementation of remedial alternatives, per Section 7 of the Endangered Species Act.
NPDES Storm Water Regulations	40 CFR Part 122	Establishes requirements for discharge of storm water	**Yes**/--	Storm water from the site could potentially enter Crow Creek as a result of remedial activities, making substantive requirements applicable. One alternative will create a point source discharge of surface water runoff into Crow Creek.
Clean Air Act	42 USC 7401–7642	Establishes air quality standards to protect public health and the environment	**Yes**/--	Substantive requirements apply. Implementation of the remedial activities may cause fugitive dust and other emissions
National Primary and Secondary Ambient Air Quality Standards and Emissions	40 CFR Part 61, Subpart A	Establishes standards for carbon monoxide, nitrogen oxide, ozone, sulfur dioxide, particulate matter, and lead	**Yes**/--	Dust or gaseous emissions during excavation or remediation will be subject to national ambient air quality standards unless state standards are more stringent.

TABLE 2-2
POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation(s)	Description	Applicable/ Relevant and Appropriate[1]	Comments
Resource Conservation and Recovery Act	42 USC 6901-6992	Establishes standards for the generation, characterization, handling, management, transportation, treatment and disposal of hazardous waste.	**Yes**/--	While RCRA would be generally applicable in any action where the management of hazardous waste would occur, the Wyoming Environmental Quality Act authorizes in W.S. 35-11-503 the promulgation of the Wyoming Solid Waste Management Rules and Regulations (WSWMRR) and the Wyoming Hazardous Waste Rules and Regulations (WHWRR) by adopting rules and regulations that are consistent and equivalent to the Resource Conservation and Recovery Act (RCRA). Thus, the WSWMRR has primacy over RCRA in the state of Wyoming
State of Wyoming				
Wyoming Solid Waste Management Rules and Regulations	Chapter 1	General provisions, definitions, and permitting procedures for new and existing solid waste facilities.	No/*see Table 2-4*	*see Table 2-4*
	Chapter 2, Sections 6, 7	Regulates the monitoring and closure of sanitary landfills	No/*see Table 2-4*	*see Table 2-4*
	Chapter 15	General provisions, definitions, and minimum construction and operating standards for new and existing solid waste disposal and processing operations.	No/*see Table 2-4*	*see Table 2-4*
Wyoming Environmental Quality Act	Article 5, W.S. 35-11-516, 519	Provides requirements for hazardous waste generators, transporters, and corrective action	**Yes**/--	If hazardous waste is generated during excavation or long term monitoring, this chapter would apply. It is applicable as necessary to implement other substantive requirements.

TABLE 2-2
POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation(s)	Description	Applicable/ Relevant and Appropriate[1]	Comments
Wyoming Water Quality Rules and Regulations	Chapter I, Section 10	Provides requirements for testing procedures	**Yes**/--	Where standard methods of testing have not been established, the suitability of testing procedures shall be determined by USAF in consultation with WDEQ and EPA using defensible scientific methods.
	Chapter I, Section 18	Establishes human health values for surface waters	**Yes**/--	Applies if surface water is impacted by contaminants from Landfill 7 during remediation or through future groundwater discharge.
	Chapter XI, Part G	Standards for the design, construction and the abandonment of monitoring wells	**Yes**/--	Applicable since some remedial actions will require the abandonment of existing monitoring wells.
Wyoming Air Quality Standards and Regulations	Chapter 2, Section 1-10	Establishes ambient air standards	**Yes**/--	Applicable to the emissions from excavation and off gasses of contaminated soils.
	Chapter 3, Section 2	Provides requirements for control of particulate emissions	**Yes**/--	Applicable to the emissions from excavation activities and off gasses of contaminated soils.
	Chapter 6, Section 2	Provides requirements for permit requirements for construction, modification, and operations	**Yes**/--	Although permits are not required, substantive requirements of BACT apply.
Wyoming Hazardous Waste Rules and Regulations	Chapter 1	Provides overview and Definitions	**Yes**/--	If hazardous waste is generated during excavation, this chapter would apply. Applicable as necessary to implement other substantive requirements.

TABLE 2-2
POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation(s)	Description	Applicable/ Relevant and Appropriate[1]	Comments
Wyoming Hazardous Waste Rules and Regulations (continued)	Chapter 2	Identifies and lists hazardous waste	**Yes**/--	If hazardous waste is generated during excavation or long term monitoring; these provisions would apply. Provisions are applicable in identifying listed or characteristic hazardous waste subject to other substantive requirements.
	Chapter 8	Sets standards for generators of hazardous waste	**Yes**/--	If hazardous waste is generated during excavation, this chapter would apply. These provisions incorporate DOT Hazardous Material Regulations found in 49 CFR Part 170–177 by reference.
	Chapter 9	Sets standards for transporters of hazardous waste	**Yes**/--	If hazardous waste is generated during excavation, this chapter would apply. These provisions incorporate DOT Hazardous Material Regulations found in 49 CFR Subtitle C.
	Chapter 13	Addresses land disposal restrictions.	**Yes**/--	If hazardous waste is generated during excavation, this chapter would apply.

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
BACT = Best available control technology
DOT = Department of Transportation
EPA = United States Environmental Protection Agency
USAF = United States Air Force
NPDES = National Pollutant Discharge Elimination System
USC = United States Code
WDEQ = Wyoming Department of Environmental Quality
W. S. = Wyoming Statute

TABLE 2-3
POTENTIAL LOCATION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate[1]	Comments
Federal				
Endangered Species Act (ESA)	16 USC, Section 1531; 50 CFR, Parts 17 and 402	Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	**Yes**/--	Areas to be remediated are in proposed Critical Habitat of the Preble's meadow jumping mouse (*Zapus hudsonius preblei).* Section 7 of the ESA *r*equires that the USAF consult with the US Fish and Wildlife Service prior to implementation of remedial alternatives.
State of Wyoming				
Wyoming Solid Waste Management Rules and Regulations	Chapter 2, Section 3	Regulates the location of sanitary landfills	No/*see Table 2-4*	*see Table 2-4*
Wyoming Water Quality Rules and Regulations	Chapter 1, Appendix A	Provides classifications for surface waters	**Yes**/--	Crow Creek is classified as 2AB. This classification determines permissible impacts to Crow Creek from adjacent activities.

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

CFR = Code of Federal Regulations
USC = United States Code

TABLE 2-4
POTENTIAL WYOMING SOLID WASTE RELEVANT AND APPROPRIATE REQUIREMENTS
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Relevant and Appropriate[1]	Comments
Chapter 2 – Sanitary Landfills, Wyoming Solid Waste Management Rules and Regulations	Appendices A and B	Lists chemical compounds, analytical methods, and detection limits to be used for monitoring sanitary landfills.	No	The suitability of testing procedures shall be determined by USAF in consultation with WDEQ and EPA.
Chapter 1 – General Provisions	All	Provides general provisions, definitions, and permit application procedures for new and existing solid waste facilities.	No	Referenced by citations in Chapter 2 of the Solid Waste Management Rules and Regulations.
Chapter 2 – Sanitary Landfills, Wyoming Solid Waste Management Rules and Regulations	Section 6	Provides minimum standards for monitoring during landfill operation.	No	Not relevant and appropriate since Landfill 7 operations ceased no later than 1959.
	Section 7(c)	Requires the prevention of erosion and/or ponding of the final cover over closed sanitary landfills.	**Yes**	Landfill cells were not graded for drainage when landfill operations ceased.
	Section 7(d)	Provides specifications for the final cover over closed sanitary landfills.	No	Specifications are for closing or recently closed sanitary landfills, and do not account for settling and compaction that would occur over a 45-year period, or the nature of the contents of Landfill 7 (contents are primarily ash, inert non-combustible materials, and non-putrescent wastes).
	Section 7(e)	Requires revegetation to minimize wind and water erosion.	**Yes**	An appropriate vegetative cover was not established over landfill cells when landfill operations ceased.
	Section 7(h)	Requires access control during closure and revegetation of sanitary landfills.	**Yes**	Access control during closure and revegetation is relevant and appropriate to minimize erosion and allow vegetation to become established.
	Section 7(k)	Requires maintenance and operation of environmental monitoring systems during closure and post-closure of sanitary landfills.	**Yes**	Maintenance and operation of environmental monitoring systems (long-term monitoring) is relevant and appropriate to evaluate the effectiveness of remedial alternatives.

TABLE 2-4
POTENTIAL WYOMING SOLID WASTE RELEVANT AND APPROPRIATE REQUIREMENTS
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Relevant and Appropriate[1]	Comments
Chapter 2 – Sanitary Landfills, Wyoming Solid Waste Management Rules and Regulations (continued)	Section 7(p)	Requires that sanitary landfills be returned to post-closure land use(s) specified in permit	No	No permit was issued for Landfill 7 and so post-closure land uses were not specified. Institutional controls will be used to permit post-closure uses that are compatible with the chosen remedial alternative.
Chapter 15 – Solid Waste Management Rules and Regulations	All	Provides general provisions, definitions, and minimum construction and operating standards for new and existing solid waste disposal and processing operations.	No	No permit was issued for Landfill 7. All construction, processing and disposal was completed no later than 1959, predating the regulations. This chapter is cited by Chapter 2 of the Solid Waste Management Rules and Regulations.
Chapter 2 – Sanitary Landfills, Wyoming Solid Waste Management Rules and Regulations	Section 3(a)(iii)	Regulates the location of new sanitary landfills relative to buildings.	No	Landfill 7a is within 300 feet of occupied structures without methane gas protection. However, siting and operation of Landfill 7 predated the regulation.
	Section 3(a)(vi)	Prohibits locating new sanitary landfills within 300 feet of surface waters.	No	Landfills are within 300 feet of Crow Creek. However, siting and operation of Landfill 7 predated the regulation.
	Section 3(a)(vii)	Prohibits locating new sanitary landfills within a 100-year floodplain.	No	Landfills are located within 100-year flood plain. However, siting and operation of Landfill 7 predated the regulation.
	Section 3(a)(viii)	Prohibits locating new sanitary landfills in a wetland.	No	A portion of Landfill 7a adjacent to Crow Creek may be in wetland. However, siting and operation of Landfill 7 predated the regulation.
	Section 3(a)(xv)	Prohibits locating a new sanitary landfill where it would have a detrimental effect on groundwater quality.	No	Waste in Landfill 7 is in contact with groundwater. However, siting and operation of Landfill 7 predated the regulation.

Notes:

1) The potential ARARs in this table are not "applicable" because the siting, operation, and cessation of operations predated the regulations. This table only evaluates whether a potential requirement may be "relevant and appropriate."

ARAR = Applicable or Relevant and Appropriate Requirement
BACT = Best available control technology
CFR = Code of Federal Regulations
DOT = Department of Transportation
EPA = United States Environmental Protection Agency
NPDES = National Pollutant Discharge Elimination System
USAF = United States Air Force
USC = United States Code
WDEQ = Wyoming Department of Environmental Quality
W. S. = Wyoming Statute

TABLE 2-5
POTENTIAL CHEMICAL-SPECIFIC TO-BE-CONSIDERED CRITERION
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citations	Description	Comments
Chemical-Specific To-Be Considered Criterion			
Wyoming Voluntary Remediation Program	Interim Cleanup Objectives for Total Petroleum Hydrocarbons in Soil and Groundwater	Lists soil and groundwater clean up goals for TPH to be protective of human health and environmental quality	Interim Cleanup Objectives for Total Petroleum Hydrocarbons in Soil and Groundwater is a potential TBC criterion since TPH was detected at low levels in bulk soils and groundwater.

Notes:

TBC = to-be-considered
TPH = total petroleum hydrocarbons

TABLE 2-6
SUMMARY OF GENERAL RESPONSE ACTIONS
LANDFILL 7/FPTA1 FEASIBILITY STUDY – F.E. WARREN AFB

General Response Action	Description
No Action	No control or clean up of landfill materials. Serves as a baseline for comparison.
Institutional Controls	Legal/management controls to control or prevent present and future use and limit exposure to landfill contaminants.
In-situ Remediation	In-situ remediation at Landfill 7 involves leaving the contaminated material in place. Some possible remedial methods include capping, in-situ stabilization, or a combination of the two methods.
Ex-situ Remediation	Excavation and removal of landfill materials and impacted soils followed by treatment or disposal.

TABLE 2-7
LANDFILL 7 TECHNOLOGY SCREENING
LANDFILL 7/FPTA1 FEASIBILITY STUDY – F.E. WARREN AFB

LANDFILL 7 TECHNOLOGY SCREENING					
General Response Action	**Technology Type**	**Process Options**	**Description**	**Technical Implementability**	**Retained?**
No Action	None	No action	No institutional or remedial actions are implemented.	Implementable	Yes
Institutional Controls	Access and development restrictions	None	Prevention of exposure to landfill waste and impacted soils is achieved by preventing certain uses or activities at the site.	Implementable	Yes
In-Situ Remediation*	In-situ chemical treatment	In-situ stabilization	A stabilizing agent is added to the landfill material to provide physical stability, limit infiltration, and prohibit the formation of leachate material. The increased volume of material is left in place.	Implementable	Yes
	In-situ biological treatment	Phytoremediation	Vegetation is established in the contaminated area to degrade or absorb contaminants in the root zone. Microbial activity is encouraged in the root zone to further degrade some contaminants.	Implementable.	Yes
	In-situ physical controls	Capping	An engineered impermeable cap is installed over landfill units to prohibit infiltration and the formation of leachate.	Implementable	Yes
	In-situ physical controls	Limited action	A 1-foot thick vegetated soil cover is installed where existing cover is less than one foot thick. Landfill areas are graded to reduce infiltration and eliminate ponding and erosion.	Implementable	Yes
Ex-Situ Remediation*	Excavation and removal	Excavation and removal	All landfill contents are excavated and removed to an off-site disposal facility. Excavations are backfilled with clean material.	Implementable	Yes
	Ex-situ physical/ chemical treatment	Ex-situ stabilization	Landfill contents are excavated, stabilized, and hauled to an off-site disposal facility. Material is in its least toxic and leachable form after stabilization. Site is backfilled with clean material.	Implementable	Yes

Note:
*All active remedial technologies include stabilizing the bank of Crow Creek near Landfill 7a.

TABLE 2-8
LANDFILL 7 PROCESS OPTION EVALUATION
LANDFILL 7/FPTA1 FEASIBILITY STUDY – F.E. WARREN AFB

General Response Action	Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Issues/Comments	Retained?
No Action	None	No action	No institutional or remedial actions are implemented.	L	H	L	Does not meet RAOs. Alternative retained as required by the National Contingency Plan.	Yes
Institutional Controls	Access and development restrictions	Access and development restrictions	Prevention of exposure to landfill waste and impacted soils is achieved by preventing certain uses or activities on the site.	L	H	L	Does not address erosion potential or improve the long-term stability of the landfill. Provides incremental protection to human receptors but does not reduce infiltration.	Yes
In-Situ Remediation	In-situ biological treatment	Phytoremediation	Vegetation is established in the contaminated area that degrades or absorbs contaminants in the root zone. Microbial activity is encouraged in the root zone to further degrade some contaminants.	L	H	L	This technology has not been proven for some of the Landfill 7 COCs, and would be only minimally effective on others because of the limited growing season.	No
	In-situ chemical treatment	In-situ stabilization	The landfill material will be mixed with a stabilizing agent (Portland Cement or Quick Lime) and will be left in place. Includes stabilization of wastes in Crow Creek stream bank.	M	M	H	Meets RAOs by stabilizing landfill material and reducing infiltration through the landfill. However, the original landfill cells may not accommodate the increased volume of stabilized material.	No
	In-situ physical controls	Engineered landfill cap	An impermeable cap will be installed over the area of contamination, eliminating surface water infiltration through landfill materials and soil. Includes stabilization of wastes in Crow Creek stream bank.	H	M	M	Meets RAOs by stabilizing landfill material and eliminating infiltration through the landfill.	Yes
	In-situ physical controls	Limited action	A minimum of one-foot of vegetated cover will be added to areas with less than one foot of existing cover. The landfill will be graded to eliminate ponding and reduce infiltration and erosion. Includes stabilization of wastes in Crow Creek stream bank.	M	H	L	Meets RAOs by stabilizing landfill material and reducing infiltration through the landfill.	Yes
Ex-Situ Surface/Vadose Treatment	Ex-situ physical controls	Excavation and removal	The landfill material will be excavated and hauled to an off-site disposal facility.	H	M	H	Meets RAOs. Logistical issues associated with excavation and removal of a very large volume of material may arise.	Yes
	Ex-situ physical treatment, ex-situ chemical treatment	Ex-situ stabilization	The landfill material will be excavated, stabilized, and removed from the site in a more stabile, less toxic form.	H	M	H	Meets RAOs. Material is non-hazardous; stabilizing will not lower disposal costs.	No

Notes:
L = low
M = medium
H = high

TABLE 4-1
DETAILED ALTERNATIVE ANALYSIS
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Criterion	Alternative 1 No Action	Alternative 2 Institutional Controls	Alternative 3 Limited Action	Alternative 4 Engineered Landfill Cap	Alternative 5 Excavation and Removal
Overall protection of human health and environment	The No Action alternative does not address potential future risk associated with landfill instability and ponding, and is not protective of human protective of human health and the environment.	Institutional controls do not address potential future risk associated with landfill instability and ponding, and therefore are not protective of human health and environment.	This alternative is protective of human health and the environment because it stabilizes landfill waste and reduces concentrated infiltration zones.	This alternative is considered to be protective of human health and the environment because it stabilizes landfill waste and eliminates infiltration.	This alternative is protective of human health and the environment because it eliminates the potential for landfill waste to pose a future risk by removing the waste material.
Compliance with ARARS	Will comply with all Chemical-, Action-, and Location - specific ARARS.	Will meet the chemical- and action-specific ARARs related to long-term monitoring and the potential generation of hazardous IDW during monitoring.	Will comply with all Chemical-, Action-, and Location - specific ARARS.	Will comply with all Chemical-, Action-, and Location - specific ARARS.	Will comply with all Chemical-, Action-, and Location - specific ARARS.
Long-term effectiveness and permanence	Low long-term effectiveness and permanence. Future residual risk could increase due to erosion of landfill materials to surface water or increased infiltration. Concentrations and residual risk may decrease due to natural attenuation. Landfill materials containing several compounds above SSLs would be left in place. No current groundwater impacts from landfill wastes have been identified.	Low long-term effectiveness and permanence. Limits direct human access to waste or UXO that could be exposed in the future. Future residual risk could increase due to erosion of landfill materials to surface water or increased infiltration. Concentrations and residual risk could decrease due to natural attenuation. Landfill materials containing several compounds above SSLs would be left in place. No current groundwater impacts from landfill wastes have been identified.	Minimal residual risk. High reliability and moderate adequacy of controls. Provides long-term effectiveness because a 1-foot soil cover would reduce the potential for human contact with landfill materials and grading would reduce the potential for ponding and erosion. Landfill materials containing several compounds above SSLs would be left in place. No current groundwater impacts from landfill wastes have been identified.	Minimal residual risk. High reliability and high adequacy of controls. Highly effective in minimizing wind and water erosion, eliminating infiltration, and reducing the potential for human contact with landfill materials. Significant O&M costs for cap maintenance. Landfill materials containing several compounds above SSLs are left in place, but infiltration is eliminated. No current groundwater impacts from landfill materials have been identified.	Minimal residual risk. High reliability and high adequacy of controls. Excavation and removal of waste would remove landfill materials from the site. The potential for landfill materials and UXO to be exposed to receptors would be eliminated. The potential for contaminants to leach or erode to other media would be eliminated.
Reduction of toxicity, mobility, or volume through treatment	Will not reduce toxicity, mobility, or volume of contaminants.	Will not reduce toxicity, mobility, or volume of contaminants.	Will reduce mobility of contaminants by reducing ponding and dispersing runoff across the site.	Will reduce mobility of contaminants through containment, rather than treatment.	Will reduce TMV at the site through removal rather than treatment.
Short term effectiveness	No impacts to community, workers, or environment. Indefinite remediation time.	No impacts to community, workers, or environment. Indefinite remediation time.	Minimal impacts on community from increased truck traffic. Minimal to moderate environmental impacts during stream bank stabilization. Estimated remediation time is 4 weeks.	Minimal impacts on community from increased truck traffic. Moderate environmental impacts during stream bank stabilization. Estimated remediation time is 8-10 weeks.	Significant impacts on community from increased truck traffic, noise, dust, and odors over a long period of time. Moderate to significant environmental impacts could occur during stream bank excavation and stabilization, or during removal of waste from below the water table. Estimated remediation time is eight months.

TABLE 4-1
DETAILED ALTERNATIVE ANALYSIS
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Criterion	**Alternative 1** **No Action**	**Alternative 2** **Institutional Controls**	**Alternative 3** **Limited Action**	**Alternative 4** **Engineered Landfill Cap**	**Alternative 5** **Excavation and Removal**
Implementability	Easily implemented. No administrative or technical challenges. No monitoring.	Easily implemented. Existing monitoring wells will be used and monitoring the effectiveness is simple. A limited administrative effort is required by FEW administrative personnel to control access and development at the site.	Easily implemented. Equipment is standard and readily available. Conventional techniques would be used to cover, re-grade, and re-vegetate landfill. Monitoring the effectiveness does not present technical challenges. FEW administrative controls will be implemented to control access and development at the site.	Moderately easy to implement. An engineered landfill cap is a proven technology, and will require a minor engineering effort. Conventional construction techniques will be used. Monitoring the effectiveness does not present technical challenges. FEW administrative controls will be implemented to control access and development at the site.	Moderately difficult to implement due to the large volume of soil to be excavated, the expected eight-month duration, the need to excavate materials below the water table, and the need to identify , handle, and dispose of UXO during excavation. Negative impacts to costs and schedule could result as these challenges present themselves during remediation.
Cost					
- Capital Cost	$0	$10,893	$1,374,437	$3,817,993	$8,061,079
- O&M (total)	$0	$755,769	$1,165,849	$1,383,239	$101,446
- O&M (annual)	$0	$17,420 - $69,188*	$ 31,191 - $82,029*	$38,477 - $89,315*	$3,368 - $3,382
- NPV	$0	$1,431,071	$3,709,851	$6,632,387	$8,285,761

Notes:

*Annual O&M costs vary by year, determined primarily by the frequency of LTM. Early years incorporate more frequent LTM (higher cost) than later years

ARAR = applicable or relevant and appropriate requirements

NPV = net present value

O&M = Operations and Maintenance

LTM = long-term monitoring

IDW = investigation derived waste

TMV = toxicity, mobility, or volume

TABLE 4-2
ANALYSIS OF POTENTIAL CHEMICAL-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate[1]	Comments
Federal				
No Federal Chemical-Specific ARARs.				
State of Wyoming				
Wyoming Water Quality Rules and Regulations	Chapter I, Appendix B	Establishes surface water standards to protect public health and environmental quality by limiting levels of contaminants.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No Alternative 4 – **Yes**/-- Alternative 5 – No/No	Chapter 1 would only be applicable in the event of a discharge of material to Crow Creek. Since Crow Creek is a Class 2AB stream, the Human Health Value for Fish and Drinking standards will be used in that event *(Note: This is not the total list of constituents presented in Appendix B, but rather an abridged version based upon COCs identified in Section 1.2.3).* **Alternative 4 -** This remedial action will involve surface water discharge from the surface water collection system in the engineered landfill cap. This water will at no time come in contact with impacted soils or waste from the landfill. **Benzo(a)anthracene** - 0.0044 µg/L **Benzo(b)flouranthene** – 0.0044 µg/L **Trichloroethene (TCE)** – 2.7 µg/L **Dioxin (2,3,7,8-TCDD)** – 0.000000013 µg/L **Chromium (Total)** – 100 µg/L **Iron** – 300 µg / L **Manganese** – 50 µg/L **Selenium** – 50 µg/L

TABLE 4-2
ANALYSIS OF POTENTIAL CHEMICAL-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate[1]	Comments
Wyoming Water Quality Rules and Regulations (continued)	Chapter VIII, Table 1	Establishes groundwater standards. Chapter VIII also references standards set by National Primary Drinking Water Standards in Section 3(d)(v)	Alternative 1 – **Yes**/-- Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	Chapter VIII is applicable since Landfill 7 has the potential to leach constituents into the groundwater. The lower of the Class I Domestic Groundwater or Class II Agricultural Standard was reported. In all cases, the Class I Domestic Groundwater standard was the lower standard. *(Note: This is not the total list of constituents presented in Table 1, but rather an abridged version based upon COCs identified in Section 1.2.3).* **Trichloroethene (TCE)** – 0.005 mg/L **Dioxin (2,3,7,8-TCDD)** – 0.00000003 mg/L **Chromium (Total)** – 0.05 mg/L **Iron** – 0.3 mg/L **Manganese** – 0.05 mg/L **Selenium** – 0.01 mg/L Based on the basewide background study (USAF, 1999) the maximum detected background concentration of iron is greater than the standard within Chapter VIII: **Iron –** 0.43 mg/L

TABLE 4-2
ANALYSIS OF POTENTIAL CHEMICAL-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate[1]	Comments
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternatives 1 & 2 –** Not applicable or relevant and appropriate since the implementation of these alternatives will not result in any sort of air emission. **Alternatives 3, 4 & 5 –** Applicable since these alternatives will involve mobile point sources of emissions. **PM_{10} particulate matter:** 50 µg/m^3 – annual arithmetic mean 150 µg/m^3 – 24-hour average concentration with not more than one expected exceedance per year. **$PM_{2.5}$ particulate matter:** 15 µg/m^3 – annual arithmetic mean 65 µg/m^3 – 98th percentile 24-hour average concentration **Nitrogen Oxides:** 100 µg/m^3 (0.05 ppm) – annual arithmetic mean **Sulfur Oxides:** 60 µg/m^3 (0.02 ppm) – annual arithmetic mean 260 µg/m^3 (0.10 ppm) – maximum 24-hour concentration not to be exceeded more than once per year 1,300 µg/m^3 (0.50 ppm) – maximum 3-hour concentration not to be exceeded more than once per year **Carbon Monoxide:** 10 mg/m^3 (9 ppm) – maximum 8-hr concentration not to be exceeded more than once per year 40 mg/m^3 (35 ppm) – maximum 1-hour concentration not to be exceeded more than once per year **Ozone:** 0.08 ppm – daily maximum average 235 µg/m^3 (0.12 ppm) – maximum hourly average **Hydrogen Sulfide:** 70 µg/m^3– ½ hour average not to be exceeded more than 2 times a year 40 µg/m^3– ½ hour average not to be exceeded more than 2 times in any 5 consecutive days **Suspended Sulfates:** 0.25 mg SO_3/ 100cm^3 per day – maximum annual average 0.50 mg SO_3/ 100cm^3 per day – maximum 30 day value **Fluorides:** 3.0 µg/m^3– maximum concentration per 12-hour average 1.8 µg/m^3– maximum concentration per 24-hour average 0.5 µg/m^3– maximum concentration per 7-day average 0.4 µg/m^3– maximum concentration per 30-day average **Lead:** 1.5 µg/m^3– maximum arithmetic mean averaged over a calendar quarter

TABLE 4-2
ANALYSIS OF POTENTIAL CHEMICAL-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

ARAR	=	applicable or relevant and appropriate requirements
COC	=	contaminant of concern
MCL	=	Maximum Contaminant Level
USC	=	United States Code
WDEQ	=	Wyoming Department of Environmental Quality

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Federal				
Clean Water Act	33 USC Section 1251–1376			
NPDES Storm Water Regulations	40 CFR Part 122	Establishes requirements for discharge of storm water.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No Alternative 4 – **Yes**/-- Alternative 5 – No/No	Due to Section 121(e) of CERCLA, which states no federal, state or local permits are required for on-site Superfund response actions, no NPDES permits are required, but substantive requirements apply. **Alternatives 1, 2, 3 & 5** – NPDES Storm Water regulations are not applicable, relevant or appropriate to the scope of these alternatives, except with the occurrence of an unanticipated or accidental discharge of materials to Crow Creek. No discharge to surface waters is planned in these alternatives. **Alternative 4** – This remedial action will involve surface water discharge from the surface water collection system in the engineered landfill cap. Substantive requirements of the NPDES program would apply. This water will at no time come in contact with impacted soils or waste from the landfill. **Alternatives 3, 4 & 5** – Will disturb more than 5 acres, but the remedial actions are exempt from requiring an application for a General Permit for Storm Water Discharges from Construction Activities Disturbing 5 Acres or Greater. Best management practices will be implemented to minimize surface water runoff into Crow Creek from the remedial areas. BMPs include run-on/run-off controls such as silt fencing and run-on control berms.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Clean Air Act	42 USC 7401–7642			
National Primary and Secondary Ambient Air Quality Standards and Emissions *(Wyoming Air Quality Standards and Regulations have primacy, see Chapter 2 of the WAQSR below)*	40 CFR, Part 50	Emissions from excavation and remedial discharges of dust and gasses will be subject to national ambient air quality standards unless state standards are more stringent.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternatives 1 & 2 –** Not applicable or relevant and important since no remedial actions will result in emissions. **Alternatives 3, 4 & 5 –** Best management practices will be implemented to minimize fugitive dust emissions to comply with the Clean Air Act. BMPs include tarping/covering of soils piles and wetting of soils.
State of Wyoming				
Wyoming Environmental Quality Act	Article 5, W.S. 35-11-516, 519	Provides requirements for hazardous waste generators, transporters, and corrective action	Alternative 1 – No/No Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – No/No	**Alternative 1 –** Not applicable, relevant or appropriate since there is no purge water generated. **Alternatives 2, 3, 4, and 5 –** Applicable since the generation of hazardous waste is possible in these alternatives through the generation of purge water from groundwater monitoring or landfill waste excavation. During the transportation of hazardous waste off-site, appropriate record keeping will occur. A manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the transporter, appropriate container labeling and DOT approved vehicle placards will be used. Personnel will have necessary OSHA training described under 29 CFR 1910.120, have proper Personal Protective Equipment (PPE) available, and have medical clearance to wear proper PPE. None of the alternatives will utilize an onsite hazardous waste management facility, thus corrective action requirements are not applicable.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Solid Waste Management Rules and Regulations	Chapter 2, Section 7(c)	Requires the prevention of erosion and/or ponding of the final cover over closed sanitary landfills.	Alternative 1 – No/No. Alternative 2 – No/No Alternative 3 – No/**Yes** Alternative 4 – No/**Yes** Alternative 5 – No/**Yes**	Not applicable[2]. However, Section 7(c) is relevant and appropriate, because surface run-off and erosion from Landfill 7 might impact water quality in Crow Creek. **Alternative 1 & 2** – Includes no grading or other action to prevent erosion and/or ponding of the final cover. **Alternative 3** – Grading and revegetation will be implemented to prevent erosion and/or ponding of the final cover. **Alternative 4** – The implementation of an impermeable cap will include grading and revegetation. **Alternative 5** – This alternative removes waste and impacted soils from the site, thus Section 7(c) does not apply. However, after backfilling clean fill material, the surface will be revegetated and graded to prevent erosion.
	Chapter 2, Section 7(e)	Requires revegetation to minimize wind and water erosion.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/**Yes** Alternative 4 – No/**Yes** Alternative 5 – No/**Yes**	Not applicable[2]. However Section 7(e) is relevant and appropriate to minimize erosion at Landfill 7a and 7b. **Alternative 1 & 2** – Include no action to disturb existing vegetation. **Alternative 3 & 4** – Revegetation will be implemented to prevent erosion and/or ponding of the final cover. **Alternative 5** – This alternative removes waste and impacted soils from the site, thus Section 7(e) does not apply. However, after backfilling clean fill material, the surface will be revegetated to prevent erosion.
	Chapter 2, Section 7(h)	Requires access control during closure and revegetation of sanitary landfills.	Alternative 1 – No/No Alternative 2 – No/**Yes** Alternative 3 – No/**Yes** Alternative 4 – No/**Yes** Alternative 5 – No/**Yes**	Not applicable[2]. However, Section 7(h) is relevant and appropriate to limit erosion during revegetation by controlling site access. **Alternative 1** – Access control not required. **Alternative 2** – Institutional controls are part of alternative. **Alternative 3, 4 & 5** – Institutional controls will be implemented to control access during remediation.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Solid Waste Management Rules and Regulations (continued)	Chapter 2, Section 7(k)	Requires maintenance and operation of environmental monitoring systems during closure and post-closure of sanitary landfills.	Alternative 1 – No/No Alternative 2 – No/**Yes** Alternative 3 – No/**Yes** Alternative 4 – No/**Yes** Alternative 5 – No/No	Not applicable[2]. However, Section 7(k) is relevant and appropriate to be protective of the environment and human health. **Alternatives 1 and 5** – Not applicable, relevant or appropriate since there is no monitoring. **Alternatives 2, 3, and 4** – Five upgradient and five downgradient wells will be monitored quarterly for three years, semiannually for five years and annually for 22 years.
Wyoming Water Quality Rules and Regulations	Chapter I, Section 18	Establishes human health values for surface waters	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No Alternative 4 – **Yes**/No. Alternative 5 – No/No	**Alternative 1, 2, 3 & 5** -These remedial actions will not include discharge into surface waters. Not applicable, relevant or appropriate to the scopes of these alternatives, except with the occurrence of an unanticipated discharge of materials to Crow Creek. **Alternative 4** – Applicable since this remedial action will involve surface water discharge from the surface water collection system in the engineered landfill cap. This water at no time will come in contact with impacted soils or waste from the landfill. **Alternative 3, 4 & 5 -** Best management practices, such as run-on/run-off controls (silt fences, hay bales, run-on control berms) will be implemented to minimize surface water runoff into Crow Creek from the remedial areas. Excavation activities are not anticipated to affect the floodplain and/or wetlands areas associated with Crow Creek.
	Chapter XI, Part G	Standards for the Design and Construction and for the Abandonment of Monitor Wells	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternatives 1 & 2** – Not applicable or relevant and appropriate since no groundwater monitoring wells will be abandoned as a result of the implementation of these alternatives. **Alternative 3, 4 & 5 -** Applicable since the abandonment of groundwater monitoring wells will be required. Wells will be abandoned according to guidelines in this Chapter.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Air Quality Standards and Regulations	Chapter 2, Sections 1-10	Establishes ambient air standards.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	Applicable to active alternatives since remedial actions, especially excavation activities, may result in emissions to atmosphere. Emissions from these remedial actions will not exceed the following ambient standards: **PM_{10} particulate matter:** 50 µg/m^3 – annual arithmetic mean 150 µg/m^3 – 24-hour average concentration with not more than one expected exceedance per year. **$PM_{2.5}$ particulate matter:** 15 µg/m^3 – annual arithmetic mean 65 µg/m^3 – 98th percentile 24-hour average concentration **Nitrogen Oxides:** 100 µg/m^3 (0.05 ppm) – annual arithmetic mean **Sulfur Oxides:** 60 µg/m^3 (0.02 ppm) – annual arithmetic mean 260 µg/m^3 (0.10 ppm) – maximum 24-hour concentration not to be exceeded more than once per year 1,300 µg/m^3 (0.50 ppm) – maximum 3-hour concentration not to be exceeded more than once per year **Carbon Monoxide:** 10 mg/m^3 (9 ppm) – maximum 8-hr concentration not to be exceeded more than once per year 40 mg/m^3 (35 ppm) – maximum 1-hour concentration not to be exceeded more than once per year **Ozone:** 0.08 ppm – daily maximum average 235 µg/m^3 (0.12 ppm) – maximum hourly average **Hydrogen Sulfide:** 70 µg/m^3– ½ hour average not to be exceeded more than 2 times a year 40 µg/m^3– ½ hour average not to be exceeded more than 2 times in any 5 consecutive days **Suspended Sulfates:** 0.25 mg SO_3/ 100cm^3 per day – maximum annual average 0.50 mg SO_3/ 100cm^3 per day – maximum 30 day value **Fluorides:** 3.0 µg/m^3– maximum concentration per 12-hour average 1.8 µg/m^3– maximum concentration per 24-hour average 0.5 µg/m^3– maximum concentration per 7-day average 0.4 µg/m^3– maximum concentration per 30-day average **Lead:** 1.5 µg/m^3– maximum arithmetic mean averaged over a calendar quarter **Alternative 3, 4 & 5 -** Will utilize BMPs, such as tarping/covering of soil piles and wetting of soils, to limit the emission of fugitive dust.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Air Quality Standards and Regulations (continued)	Chapter 3, Section 1,2,6	Provides general emission standards and requirements for emission control for fugitive dust and volatile organic compounds (VOCs)	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	Applicable when remedial actions have the potential for emitting fugitive dust and VOCs. <u>Fugitive Dust:</u> **Alternative 1 & 2** – Not applicable or relevant or appropriate since no emissions are anticipated. **Alternatives 3, 4, & 5** – BMPs, such as tarping and watering, will be used in the remedial area to limit the emission of fugitive dust during excavation. For off-site disposal, the trucks will be tarped to prevent fugitive dust emission. <u>VOCs:</u> **Alternative 1 & 2** – Not applicable or relevant or appropriate since no emissions are anticipated. **Alternatives 3, 4, & 5** – Field monitoring will be performed to ensure air quality is maintained with respect to VOCs. A Best Available Control Technology will be implemented if necessary, although it is not expected.
	Chapter 6, Section 2, 4	Provides requirements for permits for construction, modification, and operations. Chapter 6 also defines 'BACT' in Section 4(a)(vii) and regulates it use and implementation in Section 2(c)(v).	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	Substantive provisions are applicable. However, due to Section 121(e) of CERCLA, which states that no federal, state or local permits are required for on-site Superfund response actions, permits are not required. **Alternative 1 & 2** – Not applicable or relevant and appropriate since these remedial actions will not involve any construction or reconstruction. **Alternatives 3, 4, & 5 –** Applicable or relevant and appropriate to the implementation of these alternatives due to their potential emit fugitive dust or VOCs during excavation and construction activities. A Best Available Control Technology (BACT) will be implemented if emissions exceed regulatory standards set forth in Chapter 2 and 5 of WAQRR, although it is not anticipated.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Hazardous Waste Rules and Regulations (*The WEQA gives authorization to the WHWRR to adopt RCRA regulations at a State level*)	Chapter 1, 2, and 8	Provides overview and definitions, identifies and lists hazardous waste, and sets standards for generators of hazardous waste	Alternative 1 – No/No Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternative 1** – Not applicable, relevant or appropriate because no hazardous waste is generated. **Alternatives** – Applicable since the generation of investigative derived waste (IDW) from groundwater monitoring might be hazardous by the criterion listed in Section 1 of Chapter 2. If IDW is determined to be hazardous, it will be properly packaged, labeled, manifested and transported to an appropriate, permitted facility for disposal or treatment. **Alternative 5** – Applicable and relevant and appropriate. Excavated soil and waste that is characteristically hazardous will be managed as a hazardous waste. Excavated impacted soil or waste will be characterized using TCLP analysis. After characterization, the contaminated soil and waste will be packaged and labeled, if necessary, and placed onto trucks for disposal, well within the 90-day accumulation time period. If dewatering is performed, the collected water will be analyzed and managed as a hazardous waste as necessary.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate [1]	Comments
Wyoming Hazardous Waste Rules and Regulations (continued)	Chapter 9	Sets standards for transporters of hazardous waste	Alternative 1 – No/No Alternative 2 – **Yes**/-- Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternative 1** – Not applicable, relevant or appropriate because no hazardous waste will be generated. **Alternatives 2, 3, and 4** – Applicable if the purge water from groundwater monitoring is determined to be hazardous and off-site disposal is necessary. Proper shipping papers will be prepared, a manifest (for hazardous material) or bill of lading (for non-hazardous material) will be given to the transporter to track and provide a record of the quantity of purge water. Trucks hauling the hazardous material will be properly placarded and will follow all applicable Department of Transportation (DOT) regulations regarding transportation of hazardous waste. A decontamination pad will be constructed at the truck exit to remove residual soil from dump truck tires to avoid contaminating nearby roadways. **Alternative 5** – Applicable if off-site hazardous waste disposal is necessary. The trucks will be tarped to prevent soil and debris from contaminating the haul route, and a manifest (for hazardous material) or bill of lading (for nonhazardous material) will be given to the transporter to track and provide a record of the quantity of excavated soil. Trucks hauling the hazardous material will be properly placarded and will follow all applicable Department of Transportation (DOT) regulations regarding transportation of hazardous waste. A decontamination pad will be constructed at the truck exit to remove residual soil from dump truck tires to avoid contaminating nearby roadways.
	Chapter 13	Addresses land disposal restrictions.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No Alternative 4 – No/No Alternative 5 – **Yes**/--	**Alternative 1, 2, 3 & 4** – Not applicable or relevant and appropriate since the implementation of these alternatives does not involve the act of placement. **Alternative 5** – Applicable if the act of placement would occur and if waste were characterized as hazardous by TCLP analysis. For off-site disposal, all waste deemed hazardous will be transported to an appropriate, permitted Subtitle C hazardous waste management facility for treatment or disposal.

TABLE 4-3
ANALYSIS OF POTENTIAL ACTION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

2) The construction, operation and closure of Landfill 7 predates the promulgation of the Wyoming Solid Waste Management Rules by the Wyoming Environmental Quality Act

ACM	=	asbestos-containing materials
ARAR	=	Applicable or Relevant and Appropriate Requirement
BACT	=	Best Available Control Technology
BMP	=	Best Management Practice
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	=	Code of Federal Regulations
DOT	=	Department of Transportation
EPA	=	United States Environmental Protection Agency
IDW	=	investigative derived waste
LDR	=	Land Disposal Restriction
NPDES	=	National Pollutant Discharge Elimination System
OSHA	=	Occupational Safety and Health Administration
PPE	=	personal protective equipment
RACM	=	regulated asbestos-containing material
TCLP	=	Toxicity Characteristic Leaching Procedure
TSD	=	Treatment, Storage, Disposal
USAF	=	United States Air Force
USC	=	United States Code
VOCs	=	volatile organic compounds
WEQA	=	Wyoming Environmental Quality Act
WDEQ	=	Wyoming Department of Environmental Quality
WAQSR	=	Wyoming Air Quality Standards and Regulations
WHWRR	=	Wyoming Hazardous Waste Rules and Regulations
W. S.	=	Wyoming Statute

TABLE 4-4
ANALYSIS OF POTENTIAL LOCATION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate[1]	Comments
Federal				
Endangered Species Act	16 USC, Section 1531; 50 CFR, Parts 17 and 402	Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – **Yes**/-- Alternative 4 – **Yes**/-- Alternative 5 – **Yes**/--	**Alternative 1 & 2 –** Not applicable or relevant and appropriate since no Critical Habitat for any endangered species will be disturbed during the implementation of these alternatives. **Alternative 3, 4 & 5 –** The Endangered Species Act is applicable since the remediation area will impact Critical Habitat for Preble's meadow jumping mouse (*Zapus hudsonius preblei)*. The ESA has defined Critical Habitat as 394 feet on either side of Crow Creek. The USAF will consult with the US Fish and Wildlife Service prior to implementation of remedial alternatives per Section 7 of the Endangered Species Act.
State of Wyoming				
Wyoming Water Quality Rules and Regulations	Chapter 1, Appendix A	Provides classifications for surface waters	Alternative 1 – No/No Alternative 2 – No/No Alternative 3 – No/No Alternative 4 – **Yes**/-- Alternative 5 – No/No	Chapter 1 of the WWQRR is applicable if an alternative will discharge into surface waters. **Alternatives 1, 2, 3, 4 & 5 –** The restrictions associated with Crow Creek's designation as Class 2AB will be considered during the evaluation of alternatives. **Alternative 4** – This remedial action will involve surface water discharge from the surface water collection system in the engineered landfill cap. This water will at no time come in contact with impacted soils or waste from the landfill. **Alternatives 3, 4 & 5 –** Due to the close proximity to Crow Creek, best management practices (BMPs) will be implemented to prevent impacts to Crow Creek. BMPs include run-on/ run-off controls such as silt fencing and run-on control berms.

TABLE 4-4
ANALYSIS OF POTENTIAL LOCATION-SPECIFIC ARARs
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

CFR	=	Code of Federal Regulations
NA	=	Not applicable
USC	=	United States Code
Yes/--	=	Since the requirement is determined to be applicable, the relevant and appropriate determination is not necessary

TABLE 4-5
ANALYSIS OF TO-BE-CONSIDERED CRITERION
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Standard, Requirement, Criterion, or Limitation	Citation	Description	Comments
Chemical Specific To-Be Considered Criterion			
Interim Cleanup Objectives for Total Petroleum Hydrocarbons in Soil and Groundwater	WDEQ VRP Guidance Fact Sheet (WDEQ 2001)	Lists soil and groundwater clean up goals for TPH to be protective of human health and environmental quality	Interim Cleanup Objectives for Total Petroleum Hydrocarbons in Soil and Groundwater is not an ARAR since that requirement is not applicable or relevant and appropriate. It is to be considered since TPH was detected in soils and groundwater. All TPH detections in either groundwater or soil were substantially less than the clean up objectives. **Groundwater:** TPH, GRO – 7.3 mg/L Benzene – 0.005 mg/L Toluene – 1.0 mg/L Ethyl benzene – 0.7 mg/L Xylene – 10 mg/L Naphthalene – 1.5 mg/L TPH, DRO – 1.1 mg/L **Soil:** TPH, GRO – 28–15,600[3] mg/kg TPH, DRO – 2300 mg/kg

Notes:

1) An ARAR cannot be both "applicable" and "relevant and appropriate" (either "Yes/--" or "No/Yes"). If an ARAR is determined to be "applicable" the determination of "relevant and appropriate" is not needed (i.e. "Yes/--") since the "applicable" determination already makes that requirement of an environmental law an ARAR.

2) TBC criteria are not subject to the applicable or relevant and appropriate determination since they are not technically ARARs

3) Cleanup levels based on fate and transport evaluation for the protection of groundwater to the TPH GRO groundwater standard. It is dependent upon two site-specific parameters: 1) depth to seasonal high groundwater table and 2) thickness of contaminated zone.

ARAR = applicable or relevant and appropriate requirements
COC = contaminant of concern
MCL = Maximum Contaminant Level
TBC = to be considered
USC = United States Code
WDEQ = Wyoming Department of Environmental Quality

TABLE 4-6
COMPARATIVE ANALYSIS
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Criterion	Surpasses the Criterion and/or Clearly the Best Alternative(s)	Cleary Meets the Criterion and/or Very Effective Alternative(s)	Minimally Meets Criterion and/or Moderately Effective Alternative(s)	Does Not Meet Criterion and/or clearly the Least Effective Alternative(s)
Overall protection of human health and envirnoment	Alternative 5	Alternatives 3 and 4		Alternatives 1 and 2 [(1)]
Compliance with ARARS		Alternatives 3, 4, and 5		
Long-term effectiveness and permanence	Alternative 5	Alternatives 3 and 4		
Reduction of toxicity, mobility, or volume through treatment [(2)]			Alternatives 3, 4, and 5	
Short term effectiveness	Alternative 3	Alternative 4	Alternative 5	
Implementability	Alternative 3	Alternative 4	Alternative 5	
Cost - Capital Cost		Alternative 3	Alternative 4	Alternative 5
- NPV		Alternative 3	Alternative 4	Alternative 5
- O&M (total)		Alternative 5	Alternative 3	Alternative 4
- Annual O&M		Alternative 5	Alternative 3	Alternative 4

Notes:

[(1)] Note that because Alternatives 1 and 2 did not meet this threshold criterion, they were not evaluated against subsequent criteria.

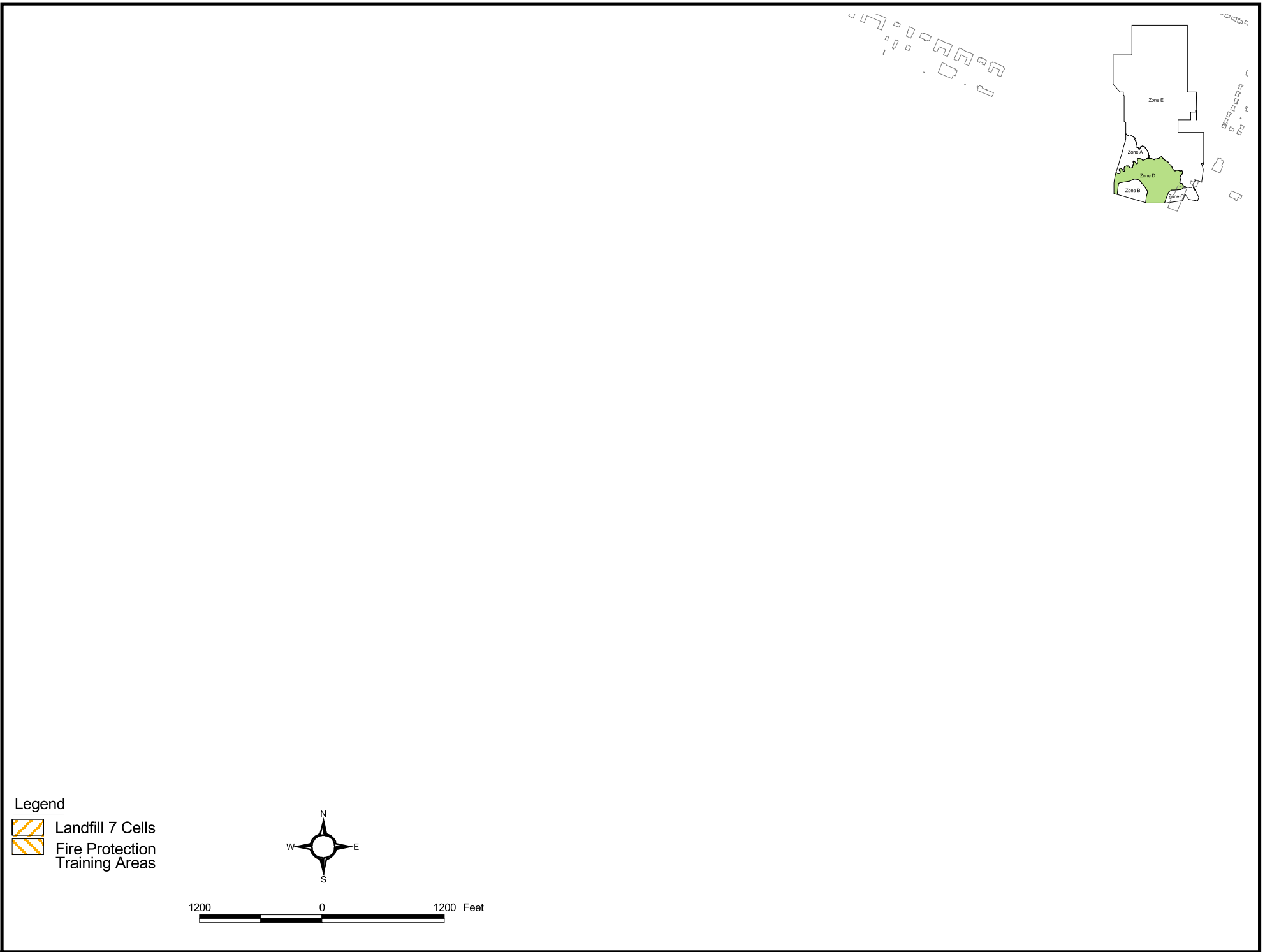
[(2)] None of the alternatives employ a "treatment" technology

ARAR = applicable or relevant and appropriate requirements

NPV = net present value

O&M = operations and maintenance

FIGURES



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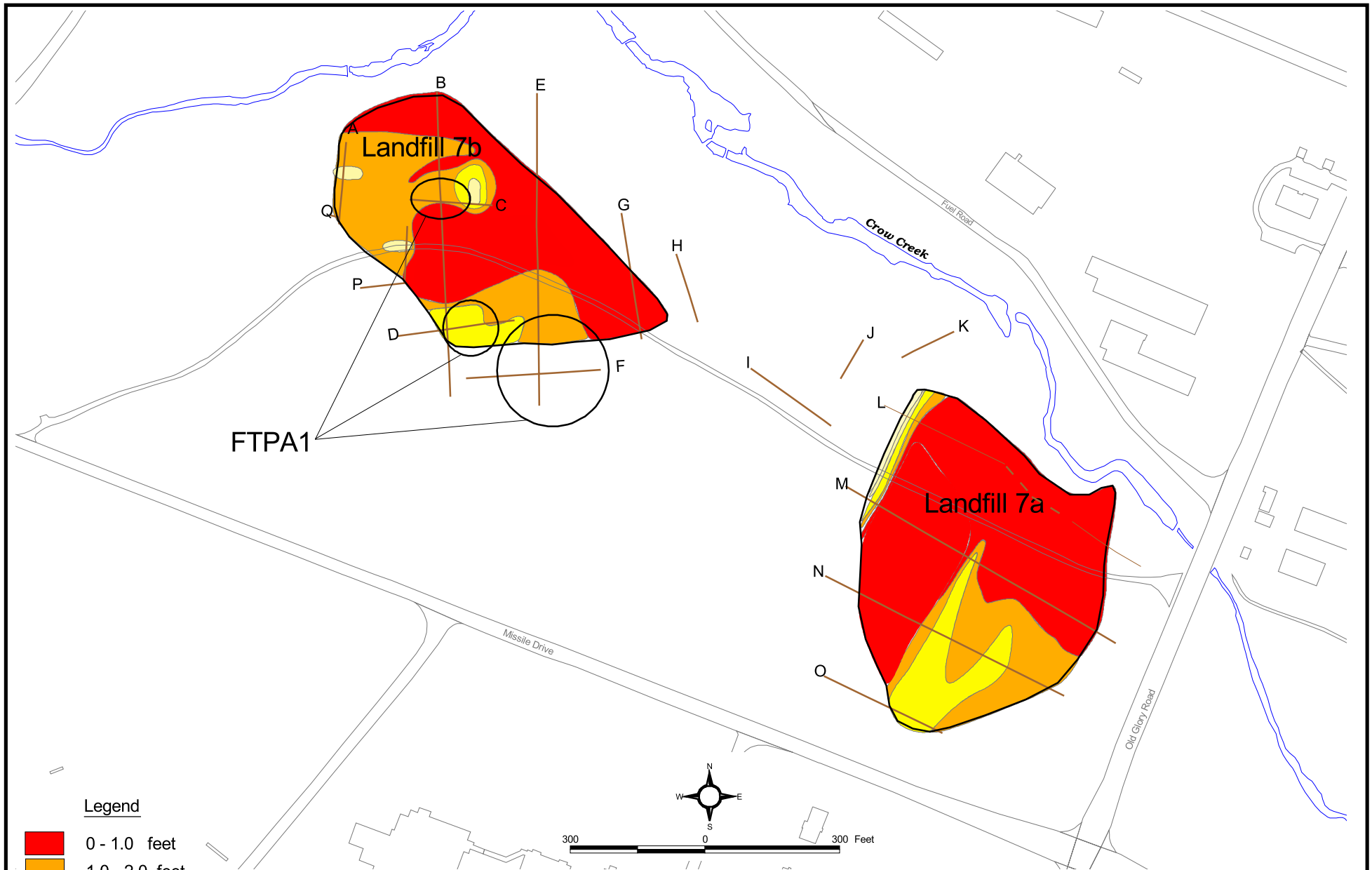
m/gis/few/project/FS_landfill7/landfill_7a_FIGS1.apr layout figure 1-2 8/13/02



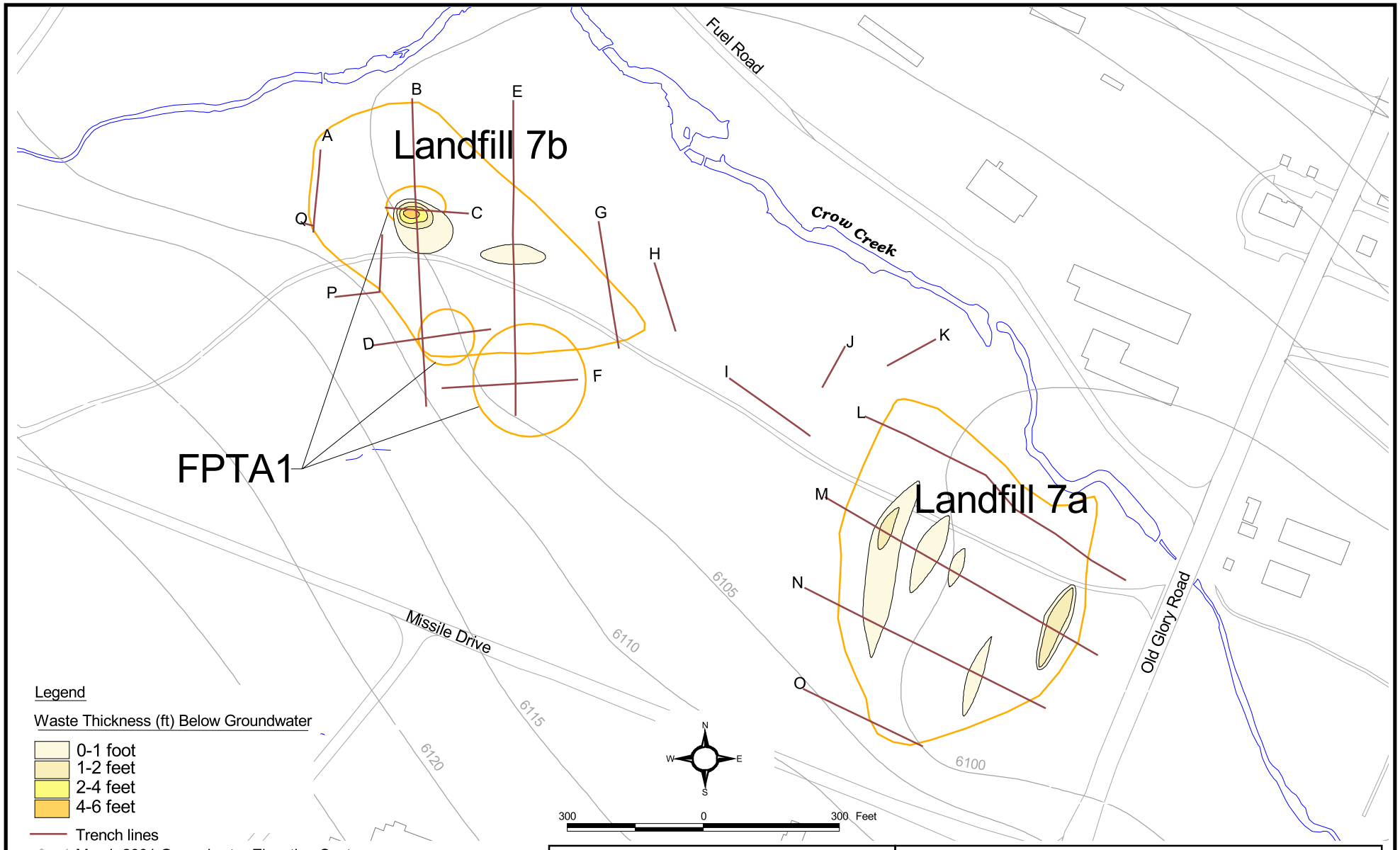
EARTH TECH

FIGURE 1-4

LANDFILL 7 SURFACE COVER

ZONE D LANDFILL 7 / FPTA1 FEASIBILITY STUDY
F.E. WARREN AIR FORCE BASE, WYOMING

m/gis/few/project/ri_Landfill7/landfill_7_figs.apr layout Figure_1-4_8x11 8/15/02



Legend

Waste Thickness (ft) Below Groundwater

- 0-1 foot
- 1-2 feet
- 2-4 feet
- 4-6 feet
- Trench lines
- March 2001 Groundwater Elevation Contour
- Landfill 7 & FPTA1 Boundary

Note:
The extent of waste depicted below groundwater was estimated based on observations during trenching activities, historical water levels, and the interpolated waste contours shown in Figure 4-2.

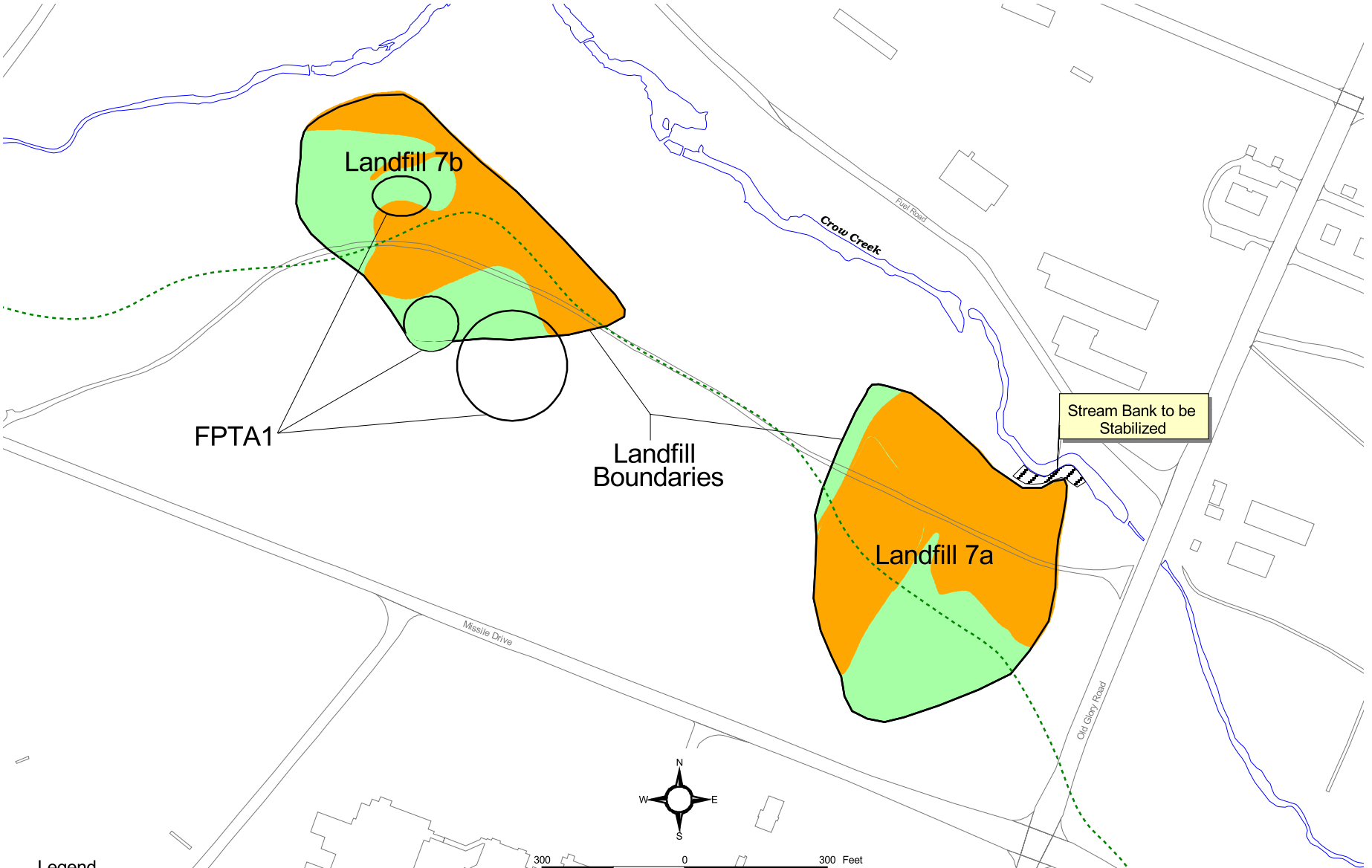
EARTH TECH

FIGURE 1-5

EXTENT OF WASTE BELOW GROUNDWATER

ZONE D LANDFILL 7 / FPTA1 FEASIBILITY STUDY
F.E. WARREN AIR FORCE BASE, WYOMING

m/gis/few/project/fs_landfill7/landfill_7.apr layout Waste in Gw 8/14/02



Legend

- Add 1.0 foot of cover grade, and revegetate (<1.0 foot of existing cover)
- Grade and revegetate to eliminate ponding and reduce erosion (1.0 - 5.0 feet of existing cover)
- Approximate extent of proposed Critical Habitat for Preble's Meadow Jumping Mouse. (394 feet from Crow Creek)

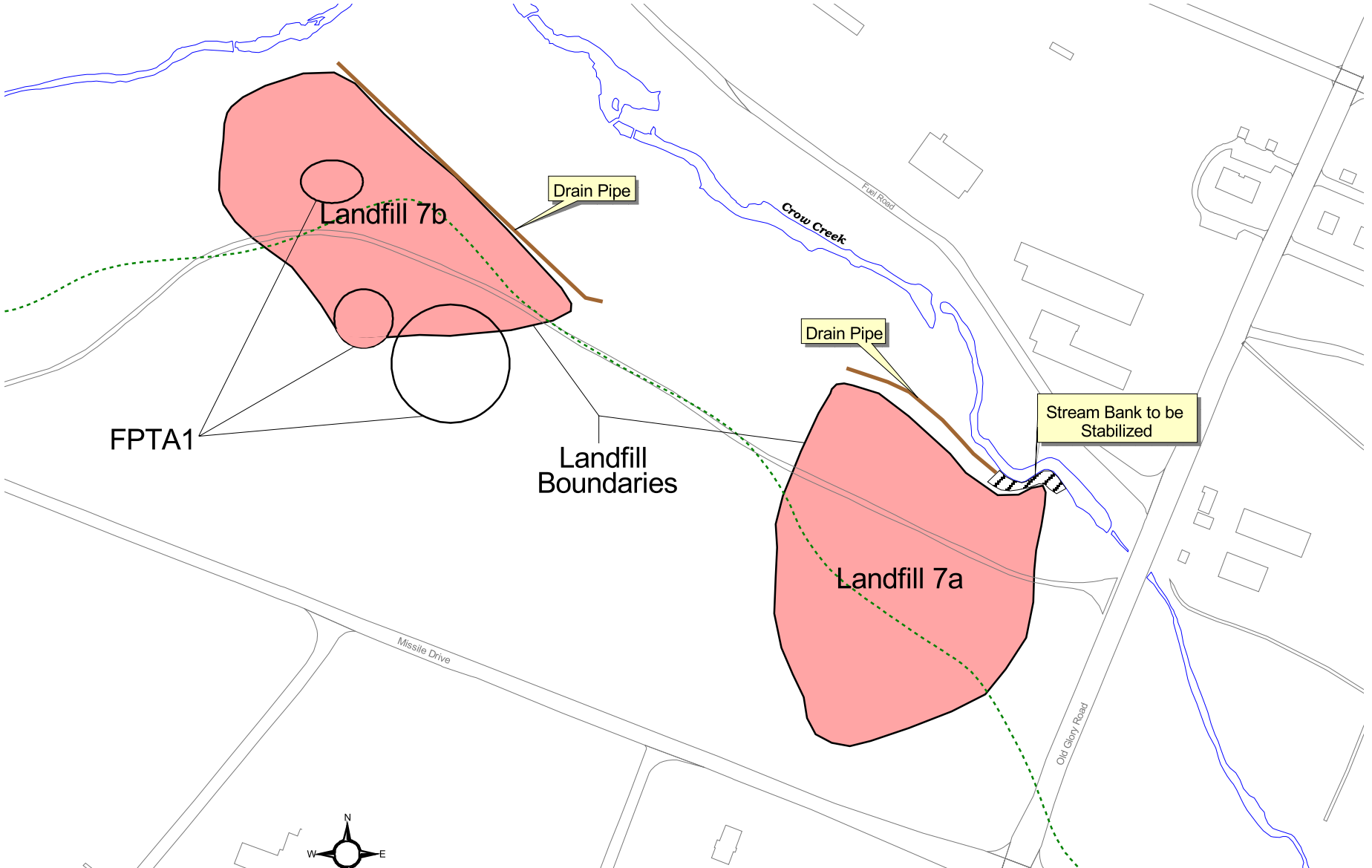
EARTH TECH

FIGURE 3-1

ALTERNATIVE 3 - LIMITED ACTION

ZONE D LANDFILL 7 / FPTA1 FEASIBILITY STUDY
F.E. WARREN AIR FORCE BASE, WYOMING

m/gis/few/project/fs_landfill7/landfill_7_figs.apr layout figure 3-3_8x11 8/13/02



Legend

300 0 300 Feet

GCL/HDPE Capping Area

Approximate extent of proposed Critical Habitat for Preble's Meadow Jumping Mouse. (394 feet from Crow Creek)

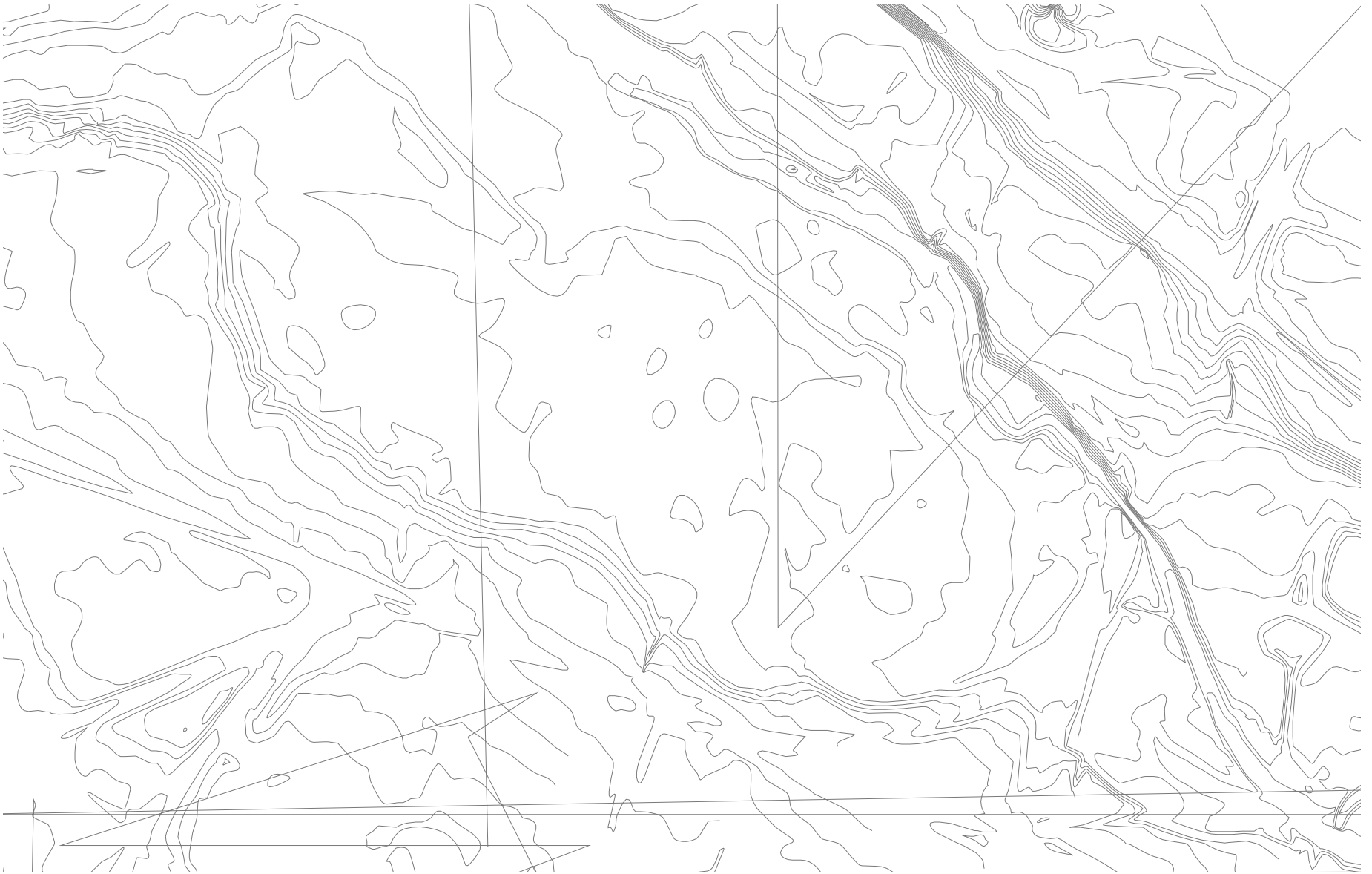
EARTH TECH

FIGURE 3-2

ALTERNATIVE 4 - ENGINEERED CAP

ZONE D LANDFILL 7 / FPTA1 FEASIBILITY STUDY
F.E. WARREN AIR FORCE BASE, WYOMING

m/gis/few/project/fs_landfill7/landfill_7_figs.apr layout figure 3-4_8x11 8/13/02



m/gis/few/project/fs_landfill7/landfill_7_figs.apr layout figure 3-5_8x11 8/13/02

APPENDIX A

ALTERNATIVE 2 COST ANALYSIS
INSTITUTIONAL CONTROLS

ALTERNATIVE 2: INSTITUTIONAL CONTROLS
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA2 - Institutional Controls LF7
Project Type: None
Project ID: RA2 - Institutional Controls LF7

Phase Name: LF7 Insitutional Controls
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Volatile Organic Compounds (VOCs)
Markup Template: System Defaults

Technology Name	Fiscal Year Year 1 2004	Fiscal Year Year 2 2005	Fiscal Year Year 3 2006	Fiscal Year Year 4 2007	Fiscal Year Year 5 2008	Fiscal Year Year 6 2009	Fiscal Year Year 7 2010	Fiscal Year Year 8 2011	Fiscal Year Year 9 2012	Fiscal Year Year 10 2013	Fiscal Year Year 11 2014
Ordnance & Explosive Institutional Controls	$10,893										
Groundwater (quarterly)	$37,737	$37,737	$37,737								
Groundwater (semi-annually)				$18,922	$18,922	$18,922	$18,922	$18,922			
Groundwater (annually)									$10,129	$10,129	$10,129
General Monitoring (quarterly)	$31,451	$31,451	$31,451								
General Monitoring (semi-annually)				$14,071	$14,071	$14,071	$14,071	$14,071			
General Monitoring (annually)									$7,291	$7,291	$7,291
Sub-Total	$80,081	$69,188	$69,188	$32,993	$32,993	$32,993	$32,993	$32,993	$17,420	$17,420	$17,420
Discount Factor (5%)	1	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627
NPV	$80,081	$72,647	$76,280	$38,194	$40,103	$42,108	$44,214	$46,424	$25,737	$27,024	$28,375

Technology Name	Fiscal Year Year 12 2015	Fiscal Year Year 13 2016	Fiscal Year Year 14 2017	Fiscal Year Year 15 2018	Fiscal Year Year 16 2019	Fiscal Year Year 17 2020	Fiscal Year Year 18 2021	Fiscal Year Year 19 2022	Fiscal Year Year 20 2023	Fiscal Year Year 21 2024	Fiscal Year Year 22 2025
Ordnance & Explosive Institutional Controls											
Groundwater (quarterly)											
Groundwater (semi-annually)											
Groundwater (annually)	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129
General Monitoring (quarterly)											
General Monitoring (semi-annually)											
General Monitoring (annually)	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291
Sub-Total	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420
Discount Factor (5%)	1.710339358	1.795856326	1.885649142	1.979931599	2.078928179	2.182874588	2.292018318	2.406619234	2.526950195	2.653297705	2.78596259
NPV	$29,794	$31,284	$32,848	$34,490	$36,215	$38,026	$39,927	$41,923	$44,019	$46,220	$48,531

Technology Name	Fiscal Year Year 23 2026	Fiscal Year Year 24 2027	Fiscal Year Year 25 2028	Fiscal Year Year 26 2029	Fiscal Year Year 27 2030	Fiscal Year Year 28 2031	Fiscal Year Year 29 2032	Fiscal Year Year 30 2033	Row Total
Ordnance & Explosive Institutional Controls									$10,893
Groundwater (quarterly)									$113,211
Groundwater (semi-annually)									$94,610
Groundwater (annually)	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$10,129	$222,838
General Monitoring (quarterly)									$94,353
General Monitoring (semi-annually)									$70,355
General Monitoring (annually)	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$7,291	$160,402
Sub-Total	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$17,420	$766,662
Discount Factor (5%)	2.92526072	3.071523756	3.225099944	3.386354941	3.555672688	3.733456322	3.920129138	4.116135595	
NPV	$50,958	$53,506	$56,181	$58,990	$61,940	$65,037	$68,289	$71,703	$1,431,071

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/10/2003
Time: 1:52 PM

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Landfill 7 Feasibility Study
ID: Landfill 7
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Fiscal Year
Description: 12.68 acre landfill facility. LF7a - 5.65 ac, LF7b - 7.03 ac.

Project

Name: RA2 - Institutional Controls LF7
ID: RA2 - Institutional Controls LF7
Type: None
Description: Institutional Controls (Site Restrictions)

Phase

Name: LF7 Insitutional Controls
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ
Start Date: 10/1/2003

Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults
O&M Markup Template: N/A

Phase Technology Cost Detail Report
(without Markups)

Description: Institutional controls implemented at LF7

Phase Technology Cost Detail Report
(without Markups)

Technology: Ordnance & Explosive Institutional Controls

Element: Planning

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	32.00	HR	0.00	23.69	0.00	$758.07	☐
33220114	Word Processing/Clerical	6.00	HR	0.00	13.10	0.00	$78.61	☐
33240101	Other Direct Costs	1.00	LS	8.37	0.00	0.00	$8.37	☑
				Total Element Cost			**$1,285.49**	

Element: Implementation

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	6.00	DAY	85.00	0.00	0.00	$510.00	☑
33220108	Project Scientist	98.00	HR	0.00	23.69	0.00	$2,321.60	☐
33240101	Other Direct Costs	1.00	LS	23.22	0.00	0.00	$23.22	☑
33990105	Letter/Brochure Printing and Distribution, per Page	50.00	EA	1.68	0.00	0.00	$84.08	☐
				Total Element Cost			**$3,039.33**	

Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$4,324.82**

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	49.00	EA	8.15	0.00	0.00	$399.13	☐
33020402	Decontamination Materials per Sample	49.00	EA	7.33	0.00	0.00	$359.03	☐
33021509	Water Quality Parameter Testing Device	3.00	WK	232.56	0.00	0.00	$697.67	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	49.00	EA	205.54	0.00	0.00	$10,071.22	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	49.00	EA	324.75	0.00	0.00	$15,912.72	☐
33231186	Well Development Equipment Rental (weekly)	3.00	WK	232.56	0.00	0.00	$697.67	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	44.00	EA	9.50	0.00	0.00	$418.18	☐
				Total Element Cost			**$28,555.61**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	960.00	MI	0.36	0.00	0.00	$344.35	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	24.00	DAY	85.00	0.00	0.00	$2,040.00	☑
33220108	Project Scientist	221.00	HR	0.00	23.69	0.00	$5,235.45	☐
33220112	Field Technician	217.00	HR	0.00	15.81	0.00	$3,430.84	☐
33220114	Word Processing/Clerical	25.00	HR	0.00	13.10	0.00	$327.54	☐
33220115	Draftsman/CADD	25.00	HR	0.00	20.30	0.00	$507.60	☐
				Total Element Cost			**$11,885.78**	
				Total Technology Cost			**$40,441.38**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	25.00	EA	8.15	0.00	0.00	$203.64	☐
33020402	Decontamination Materials per Sample	25.00	EA	7.33	0.00	0.00	$183.18	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	25.00	EA	205.54	0.00	0.00	$5,138.38	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	25.00	EA	324.75	0.00	0.00	$8,118.73	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	22.00	EA	9.50	0.00	0.00	$209.09	☐
				Total Element Cost			**$14,318.13**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	420.00	MI	0.36	0.00	0.00	$150.65	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33220108	Project Scientist	113.00	HR	0.00	23.69	0.00	$2,676.95	☐
33220112	Field Technician	77.00	HR	0.00	15.81	0.00	$1,217.39	☐
33220114	Word Processing/Clerical	13.00	HR	0.00	13.10	0.00	$170.32	☐
33220115	Draftsman/CADD	13.00	HR	0.00	20.30	0.00	$263.95	☐
				Total Element Cost			**$5,159.27**	
				Total Technology Cost			**$19,477.40**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	13.00	EA	8.15	0.00	0.00	$105.89	☐
33020402	Decontamination Materials per Sample	13.00	EA	7.33	0.00	0.00	$95.25	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	13.00	EA	205.54	0.00	0.00	$2,671.96	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	13.00	EA	324.75	0.00	0.00	$4,221.74	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	11.00	EA	9.50	0.00	0.00	$104.54	☐
				Total Element Cost			**$7,664.50**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	210.00	MI	0.36	0.00	0.00	$75.33	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	59.00	HR	0.00	23.69	0.00	$1,397.70	☐
33220112	Field Technician	39.00	HR	0.00	15.81	0.00	$616.60	☐
33220114	Word Processing/Clerical	7.00	HR	0.00	13.10	0.00	$91.71	☐
33220115	Draftsman/CADD	7.00	HR	0.00	20.30	0.00	$142.13	☐

Total Element Cost	**$2,663.47**
Total Technology Cost	**$10,327.96**
Total Phase Cost	**$74,571.56**

APPENDIX B

ALTERNATIVE 3 COST ANALYSIS
LIMITED ACTION

ALTERNATIVE 3: LIMITED ACTION
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA3 - Limited Action LF7
Project Type: None
Project ID: RA3 - Limited Action LF7

Phase Name: LF7 Limited Action
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Technology Name	Fiscal Year Year 1 2004	Fiscal Year Year 2 2005	Fiscal Year Year 3 2006	Fiscal Year Year 4 2007	Fiscal Year Year 5 2008	Fiscal Year Year 6 2009	Fiscal Year Year 7 2010	Fiscal Year Year 8 2011	Fiscal Year Year 9 2012	Fiscal Year Year 10 2013	Fiscal Year Year 11 2014
Landfill Cover	$862,440										
Ordnance & Explosive Institutional Controls	$10,792										
Professional Labor Management	$261,261										
TOPSOIL AND SEEDING	$226,453										
STREAM BANK STABILIZATION	$13,491										
Groundwater (quarterly)	$36,761	$36,761	$36,761								
Groundwater (semi-annually)				$18,432	$18,432	$18,432	$18,432	$18,432			
Groundwater (annually)									$9,867	$9,867	$9,867
General Monitoring (quarterly)	$31,168	$31,168	$31,168								
General Monitoring (semi-annually)				$13,942	$13,942	$13,942	$13,942	$13,942			
General Monitoring (annually)									$7,224	$7,224	$7,224
O&M: Miscellaneous Support Costs	$4,610	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731
O&M: Landfill Cover	$9,505	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369
Sub-Total	$1,456,481	$82,029	$82,029	$46,474	$46,474	$46,474	$46,474	$46,474	$31,191	$31,191	$31,191
Discount Factor (5%)	1	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627
NPV	$1,456,481	$86,130	$90,437	$53,799	$56,489	$59,314	$62,280	$65,394	$46,083	$48,387	$50,807

Technology Name	Fiscal Year Year 12 2015	Fiscal Year Year 13 2016	Fiscal Year Year 14 2017	Fiscal Year Year 15 2018	Fiscal Year Year 16 2019	Fiscal Year Year 17 2020	Fiscal Year Year 18 2021	Fiscal Year Year 19 2022	Fiscal Year Year 20 2023	Fiscal Year Year 21 2024	Fiscal Year Year 22 2025
Landfill Cover											
Ordnance & Explosive Institutional Controls											
Professional Labor Management											
TOPSOIL AND SEEDING											
STREAM BANK STABILIZATION											
Groundwater (quarterly)											
Groundwater (semi-annually)											
Groundwater (annually)	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867
General Monitoring (quarterly)											
General Monitoring (semi-annually)											
General Monitoring (annually)	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224
O&M: Miscellaneous Support Costs	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731
O&M: Landfill Cover	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369
Sub-Total	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191
Discount Factor (5%)	1.710339358	1.795856326	1.885649142	1.979931599	2.078928179	2.182874588	2.292018318	2.406619234	2.526950195	2.653297705	2.78596259
NPV	$53,347	$56,015	$58,815	$61,756	$64,844	$68,086	$71,490	$75,065	$78,818	$82,759	$86,897

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/10/2003
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ALTERNATIVE 3: LIMITED ACTION
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA3 - Limited Action LF7
Project Type: None
Project ID: RA3 - Limited Action LF7

Phase Name: LF7 Limited Action
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Technology Name	Fiscal Year Year 23 2026	Fiscal Year Year 24 2027	Fiscal Year Year 25 2028	Fiscal Year Year 26 2029	Fiscal Year Year 27 2030	Fiscal Year Year 28 2031	Fiscal Year Year 29 2032	Fiscal Year Year 30 2033	Fiscal Year Year 31 2034	Row Total
Landfill Cover										$862,440
Ordnance & Explosive Institutional Controls										$10,792
Professional Labor Management										$261,261
TOPSOIL AND SEEDING										$226,453
STREAM BANK STABILIZATION										$13,491
Groundwater (quarterly)										$110,283
Groundwater (semi-annually)										$92,160
Groundwater (annually)	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867		$217,074
General Monitoring (quarterly)										$93,504
General Monitoring (semi-annually)										$69,710
General Monitoring (annually)	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224		$158,928
O&M: Miscellaneous Support Costs	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$3,731	$311	$113,120
O&M: Landfill Cover	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$10,369	$864	$311,070
Sub-Total	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$31,191	$1,175	$2,540,286
Discount Factor (5%)	2.92526072	3.071523756	3.225099944	3.386354941	3.555672688	3.733456322	3.920129138	4.116135595	4.321942375	
NPV	$91,242	$95,804	$100,594	$105,624	$110,905	$116,450	$122,273	$128,386	$5,078	$3,709,851

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/10/2003
Time: 1:52 PM

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Landfill 7 Feasibility Study
ID: Landfill 7
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Fiscal Year
Description: 12.68 acre landfill facility. LF7a - 5.65 ac, LF7b - 7.03 ac.

Project

Name: RA3 - Limited Action LF7
ID: RA3 - Limited Action LF7
Type: None
Description: Limited Action includes: Placement of cover material, regrading, stream bank stabilization, revegetation.

Phase

Name: LF7 Limited Action
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Cost Database Date: 2002
Cost Type: User-Defined
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Phase Technology Cost Detail Report
(without Markups)

Start Date: 10/1/2003 **O&M Markup Template:** System Defaults

Description: Soil Cover Placement, stream bank stabilization, regrading, re-vegetation.

Phase Technology Cost Detail Report
(without Markups)

Technology: Capping

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	26,002.79	CY	5.74	0.95	1.96	$224,955.33	☐
18050301	Topsoil, 6" Lifts, Off-Site	8,276.38	CY	19.45	3.83	3.08	$218,132.27	☐
18050402	Seeding, Vegetative Cover	7.94	ACRE	3,572.78	64.32	51.49	$29,287.47	☐
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	2,575.11	LF	0.05	0.49	0.17	$1,823.18	☐
33080513	Drainage Netting, Geotextile Fabric Heat-bonded 2 Sides	393,293.40	SF	0.40	0.04	0.01	$178,476.55	☐
				Total Element Cost			**$652,674.79**	
				Total Technology Cost			**$652,674.79**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	18,151.79	0.00	$18,151.79	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	18,151.79	0.00	$18,151.79	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	22,689.73	0.00	$22,689.73	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	2,268.97	0.00	$2,268.97	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	2,268.97	0.00	$2,268.97	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	317.66	0.00	$317.66	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	22,689.73	0.00	$22,689.73	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$86,538.65**	
				Total Technology Cost			**$86,538.65**	

Cost Database Date: 2002

Cost Type: User-Defined

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Phase Technology Cost Detail Report
(without Markups)

Technology: Operations and Maintenance (12 - months only)

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33010205	Mobilize Crew, 50 Miles, per Person	8.00	EA	71.47	0.00	0.00	$571.76	☐
33010423	Disposable Gloves (Latex)	3.00	PAIR	0.22	0.00	0.00	$0.65	☐
33010425	Disposable Coveralls (Tyvek)	3.00	EA	4.55	0.00	0.00	$13.66	☐
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums)	1.00	EA	209.23	0.00	0.00	$209.23	☐
33199921	DOT Steel Drum, 55 Gallon	1.00	EA	76.99	0.00	0.00	$76.99	☐
33220106	Staff Engineer	16.00	HR	0.00	23.22	0.00	$371.48	☐
33220112	Field Technician	16.00	HR	0.00	15.81	0.00	$252.96	☐
33240104	Startup Costs	1.00	LS	269.33	269.33	134.66	$673.31	☑
99020110	Annual Maintenance Materials and Labor	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$2,850.05**	

Phase Technology Cost Detail Report
(without Markups)

Element: Capping

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050402	Seeding, Vegetative Cover	1.00	ACRE	3,572.78	64.32	51.49	$3,688.60	☐
18050409	Fertilize, 800 Lbs/Acre, Push Rotary	16.00	ACRE	39.69	27.99	18.94	$1,386.07	☐
18050415	Mowing	48.00	ACRE	0.00	18.97	8.71	$1,328.77	☐
33220106	Staff Engineer	2.00	HR	0.00	23.22	0.00	$46.44	☐
33220112	Field Technician	8.00	HR	0.00	15.81	0.00	$126.48	☐

Total Element Cost	**$6,576.35**
Total Technology Cost	**$9,426.40**
Runtime Percent Cost Adjustment	**97%**
O & M Total Cost	**$9,143.61**

Phase Technology Cost Detail Report
(without Markups)

Technology: STREAM BANK STABILIZATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	30.00	CY	5.74	0.95	1.96	$259.54	☐
17030433	Crawler Mounted 0.5 CY Hydraulic Excavator	20.00	HR	0.00	57.25	68.15	$2,507.95	☐
17030441	Standby 0.75 CY Wheel Loader	8.00	HR	0.00	0.00	68.15	$545.18	☐
17030705	D7 with U-blade Bulldozer	20.00	HR	0.00	32.01	106.19	$2,764.02	☐
17030713	Standby, D7 with U-blade Bulldozer	8.00	HR	0.00	0.00	24.67	$197.35	☐
17040101	General Area Cleanup	1.00	ACRE	0.00	169.24	107.46	$276.71	☐
17040103	Load & Haul Debris, 5 Miles, Dumptruck	100.00	CY	0.00	1.45	2.33	$378.24	☐
18050204	Rock Cover, Riprap, Heavy (25 to 500 Lb Pieces)	50.00	CY	17.69	3.31	2.10	$1,154.51	☐
18050206	Filter Barrier	100.00	LF	0.67	1.31	0.00	$197.76	☐
33080531	6 oz/sy Geotextile, Non-Woven (60 Mil)	120.00	SY	0.64	0.40	0.02	$126.80	☐
33220112	Field Technician	40.00	HR	0.00	15.81	0.00	$632.41	☐
				Total Element Cost			**$9,040.48**	

Cost Database Date: 2002

Cost Type: User-Defined

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Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$9,040.48**

Phase Technology Cost Detail Report
(without Markups)

Technology: TOPSOIL AND SEEDING

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	4,557.00	CY	19.45	3.83	3.08	$120,104.29	☐
18050402	Seeding, Vegetative Cover	12.68	ACRE	3,572.78	64.32	51.49	$46,771.43	☐
18050413	Watering with 3,000-Gallon Tank Truck, per Pass	76.08	ACRE	4.02	24.47	29.70	$4,426.84	☐
				Total Element Cost			**$171,302.55**	
				Total Technology Cost			**$171,302.55**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	49.00	EA	8.15	0.00	0.00	$399.13	☐
33020402	Decontamination Materials per Sample	49.00	EA	7.33	0.00	0.00	$359.03	☐
33021509	Water Quality Parameter Testing Device	3.00	WK	232.56	0.00	0.00	$697.67	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	49.00	EA	205.54	0.00	0.00	$10,071.22	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	49.00	EA	324.75	0.00	0.00	$15,912.72	☐
33231186	Well Development Equipment Rental (weekly)	3.00	WK	232.56	0.00	0.00	$697.67	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	44.00	EA	9.50	0.00	0.00	$418.18	☐
				Total Element Cost			**$28,555.61**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	960.00	MI	0.36	0.00	0.00	$344.35	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	24.00	DAY	85.00	0.00	0.00	$2,040.00	☑
33220108	Project Scientist	221.00	HR	0.00	23.69	0.00	$5,235.45	☐
33220112	Field Technician	217.00	HR	0.00	15.81	0.00	$3,430.84	☐
33220114	Word Processing/Clerical	25.00	HR	0.00	13.10	0.00	$327.54	☐
33220115	Draftsman/CADD	25.00	HR	0.00	20.30	0.00	$507.60	☐
				Total Element Cost			**$11,885.78**	
				Total Technology Cost			**$40,441.38**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	25.00	EA	8.15	0.00	0.00	$203.64	☐
33020402	Decontamination Materials per Sample	25.00	EA	7.33	0.00	0.00	$183.18	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	25.00	EA	205.54	0.00	0.00	$5,138.38	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	25.00	EA	324.75	0.00	0.00	$8,118.73	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	22.00	EA	9.50	0.00	0.00	$209.09	☐
				Total Element Cost			**$14,318.13**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	420.00	MI	0.36	0.00	0.00	$150.65	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33220108	Project Scientist	113.00	HR	0.00	23.69	0.00	$2,676.95	☐
33220112	Field Technician	77.00	HR	0.00	15.81	0.00	$1,217.39	☐
33220114	Word Processing/Clerical	13.00	HR	0.00	13.10	0.00	$170.32	☐
33220115	Draftsman/CADD	13.00	HR	0.00	20.30	0.00	$263.95	☐
				Total Element Cost			**$5,159.27**	
				Total Technology Cost			**$19,477.40**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	13.00	EA	8.15	0.00	0.00	$105.89	☐
33020402	Decontamination Materials per Sample	13.00	EA	7.33	0.00	0.00	$95.25	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	13.00	EA	205.54	0.00	0.00	$2,671.96	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	13.00	EA	324.75	0.00	0.00	$4,221.74	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	11.00	EA	9.50	0.00	0.00	$104.54	☐
				Total Element Cost			**$7,664.50**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	210.00	MI	0.36	0.00	0.00	$75.33	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	59.00	HR	0.00	23.69	0.00	$1,397.70	☐
33220112	Field Technician	39.00	HR	0.00	15.81	0.00	$616.60	☐
33220114	Word Processing/Clerical	7.00	HR	0.00	13.10	0.00	$91.71	☐
33220115	Draftsman/CADD	7.00	HR	0.00	20.30	0.00	$142.13	☐
				Total Element Cost			**$2,663.47**	
				Total Technology Cost			**$10,327.96**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Ordnance & Explosive Institutional Controls

Element: Planning

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	32.00	HR	0.00	23.69	0.00	$758.07	☐
33220114	Word Processing/Clerical	6.00	HR	0.00	13.10	0.00	$78.61	☐
33240101	Other Direct Costs	1.00	LS	8.37	0.00	0.00	$8.37	☑
				Total Element Cost			**$1,285.49**	

Element: Implementation

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	6.00	DAY	85.00	0.00	0.00	$510.00	☑
33220108	Project Scientist	98.00	HR	0.00	23.69	0.00	$2,321.60	☐
33240101	Other Direct Costs	1.00	LS	23.22	0.00	0.00	$23.22	☑
33990105	Letter/Brochure Printing and Distribution, per Page	50.00	EA	1.68	0.00	0.00	$84.08	☐
				Total Element Cost			**$3,039.33**	

Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$4,324.82**
Total Phase Cost	**$1,003,271.64**

APPENDIX C

ALTERNATIVE 4 COST ANALYSIS
ENGINEERED LANDFILL CAP

ALTERNATIVE 4: ENGINEERED LANDFILL CAP
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA4 - Capping LF7
Project Type: None
Project ID: RA4 - Capping LF7

Phase Name: LF7 Capping
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults
O&M Markup Template: System Defaults

Technology Name	Fiscal Year Year 1 2004	Fiscal Year Year 2 2005	Fiscal Year Year 3 2006	Fiscal Year Year 4 2007	Fiscal Year Year 5 2008	Fiscal Year Year 6 2009	Fiscal Year Year 7 2010	Fiscal Year Year 8 2011	Fiscal Year Year 9 2012	Fiscal Year Year 10 2013	Fiscal Year Year 11 2014	Fiscal Year Year 12 2015	Fiscal Year Year 13 2016
Capping	$2,886,891												
Ordnance & Explosive Institutional Controls	$10,792												
Professional Labor Management	$676,220												
TOPSOIL AND SEEDING	$226,453												
STREAM BANK STABILIZATION	$13,491												
WELL ABANDONMENT	$4,146												
Groundwater (quarterly)	$36,761	$36,761	$36,761										
Groundwater (semi-annually)				$18,432	$18,432	$18,432	$18,432	$18,432					
Groundwater (annually)									$9,867	$9,867	$9,867	$9,867	$9,867
General Monitoring (quarterly)	$31,168	$31,168	$31,168										
General Monitoring (semi-annually)				$13,942	$13,942	$13,942	$13,942	$13,942					
General Monitoring (annually)									$7,224	$7,224	$7,224	$7,224	$7,224
O&M: Miscellaneous Support Costs	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714
O&M: Capping	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672
Sub-Total	$3,907,308	$89,315	$89,315	$53,760	$53,760	$53,760	$53,760	$53,760	$38,477	$38,477	$38,477	$38,477	$38,477
Discount Factor (5%)	1	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	1.710339358	1.795856326
NPV	$3,907,308	$93,781	$98,470	$62,234	$65,346	$68,613	$72,044	$75,646	$56,848	$59,690	$62,675	$65,809	$69,099

Technology Name	Fiscal Year Year 14 2017	Fiscal Year Year 15 2018	Fiscal Year Year 16 2019	Fiscal Year Year 17 2020	Fiscal Year Year 18 2021	Fiscal Year Year 19 2022	Fiscal Year Year 20 2023	Fiscal Year Year 21 2024	Fiscal Year Year 22 2025	Fiscal Year Year 23 2026	Fiscal Year Year 24 2027	Fiscal Year Year 25 2028	Fiscal Year Year 26 2029
Capping													
Ordnance & Explosive Institutional Controls													
Professional Labor Management													
TOPSOIL AND SEEDING													
STREAM BANK STABILIZATION													
WELL ABANDONMENT													
Groundwater (quarterly)													
Groundwater (semi-annually)													
Groundwater (annually)	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867	$9,867
General Monitoring (quarterly)													
General Monitoring (semi-annually)													
General Monitoring (annually)	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224	$7,224
O&M: Miscellaneous Support Costs	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714	$3,714
O&M: Capping	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672	$17,672
Sub-Total	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477	$38,477
Discount Factor (5%)	1.885649142	1.979931599	2.078928179	2.182874588	2.292018318	2.406619234	2.526950195	2.653297705	2.78596259	2.92526072	3.071523756	3.225099944	3.386354941
NPV	$72,554	$76,182	$79,991	$83,990	$88,190	$92,599	$97,229	$102,091	$107,195	$112,555	$118,183	$124,092	$130,297

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/10/2003
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ALTERNATIVE 4: ENGINEERED LANDFILL CAP
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA4 - Capping LF7
Project Type: None
Project ID: RA4 - Capping LF7

Phase Name: LF7 Capping
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults
O&M Markup Template: System Defaults

Technology Name	**Fiscal Year Year 27 2030**	**Fiscal Year Year 28 2031**	**Fiscal Year Year 29 2032**	**Fiscal Year Year 30 2033**	**Fiscal Year Year 31 2034**	**Row Total**
Capping						$2,886,891
Ordnance & Explosive Institutional Controls						$10,792
Professional Labor Management						$676,220
TOPSOIL AND SEEDING						$226,453
STREAM BANK STABILIZATION						$13,491
WELL ABANDONMENT						$4,146
Groundwater (quarterly)						$110,283
Groundwater (semi-annually)						$92,160
Groundwater (annually)	$9,867	$9,867	$9,867	$9,867		$217,074
General Monitoring (quarterly)						$93,504
General Monitoring (semi-annually)						$69,710
General Monitoring (annually)	$7,224	$7,224	$7,224	$7,224		$158,928
O&M: Miscellaneous Support Costs	$3,714	$3,714	$3,714	$3,714		$111,420
O&M: Capping	$17,672	$17,672	$17,672	$17,672		$530,160
Sub-Total	$38,477	$38,477	$38,477	$38,477	$0	$5,201,232
Discount Factor (5%)	3.555672688	3.733456322	3.920129138	4.116135595	4.321942375	
NPV	$136,812	$143,652	$150,835	$158,377	$0	$6,632,387

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/10/2003
Time: 1:52 PM

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Landfill 7 Feasibility Study
ID: Landfill 7
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Fiscal Year
Description: 12.68 acre landfill facility. LF7a - 5.65 ac, LF7b - 7.03 ac.

Project

Name: RA4 - Capping LF7
ID: RA4 - Capping LF7
Type: None
Description: Capping includes - installation of an engineered cap over both landfill units, stream bank stabilization, revegetation.

Phase

Name: LF7 Capping
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: In Situ
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Phase Technology Cost Detail Report
(without Markups)

Start Date: 10/1/2003 **O&M Markup Template:** System Defaults

Description: Installation of an Impermeable Cap over the Landfill units

Phase Technology Cost Detail Report
(without Markups)

Technology: Capping

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	69,042.50	CY	5.74	0.95	1.96	$597,300.48	☐
18050301	Topsoil, 6" Lifts, Off-Site	13,217.18	CY	19.45	3.83	3.08	$348,351.99	☐
18050402	Seeding, Vegetative Cover	12.68	ACRE	3,572.78	64.32	51.49	$46,771.43	☐
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	3,233.12	LF	0.05	0.49	0.17	$2,289.05	☐
33080513	Drainage Netting, Geotextile Fabric Heat-bonded 2 Sides	628,080.60	SF	0.40	0.04	0.01	$285,022.99	☐
33080571	40 Mil Polymeric Liner, High-density Polyethylene	628,080.60	SF	0.29	0.84	0.17	$811,417.36	☐

Total Element Cost	**$2,091,153.29**
Total Technology Cost	**$2,091,153.29**

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	46,982.11	0.00	$46,982.11	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	46,982.11	0.00	$46,982.11	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	58,727.63	0.00	$58,727.63	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	5,872.76	0.00	$5,872.76	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	5,872.76	0.00	$5,872.76	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	822.19	0.00	$822.19	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	58,727.63	0.00	$58,727.63	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$223,987.19**	
				Total Technology Cost			**$223,987.19**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 11/5/2002 2:54:28 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: Operations and Maintenance (12 - months only)

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33010205	Mobilize Crew, 50 Miles, per Person	8.00	EA	71.47	0.00	0.00	$571.76	☐
33010423	Disposable Gloves (Latex)	3.00	PAIR	0.22	0.00	0.00	$0.65	☐
33010425	Disposable Coveralls (Tyvek)	3.00	EA	4.55	0.00	0.00	$13.66	☐
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landfill Disp (55-Gal Drums)	1.00	EA	209.23	0.00	0.00	$209.23	☐
33199921	DOT Steel Drum, 55 Gallon	1.00	EA	76.99	0.00	0.00	$76.99	☐
33220106	Staff Engineer	16.00	HR	0.00	23.22	0.00	$371.48	☐
33220112	Field Technician	16.00	HR	0.00	15.81	0.00	$252.96	☐
99020110	Annual Maintenance Materials and Labor	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$2,176.74**	

Element: Capping

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050402	Seeding, Vegetative Cover	2.00	ACRE	3,572.78	64.32	51.49	$7,377.20	☐

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 11/5/2002 2:54:28 PM

Phase Technology Cost Detail Report
(without Markups)

Element: Capping

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050409	Fertilize, 800 Lbs/Acre, Push Rotary	26.00	ACRE	39.69	27.99	18.94	$2,252.36	☐
18050415	Mowing	77.00	ACRE	0.00	18.97	8.71	$2,131.57	☐
33220106	Staff Engineer	2.00	HR	0.00	23.22	0.00	$46.44	☐
33220112	Field Technician	8.00	HR	0.00	15.81	0.00	$126.48	☐

Total Element Cost	**$11,934.04**
Total Technology Cost	**$14,110.78**
Runtime Percent Cost Adjustment	**97%**
O & M Total Cost	**$13,687.46**

Phase Technology Cost Detail Report
(without Markups)

Technology: WELL ABANDONMENT

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33231822	Well Abandonment, 2" Well	175.00	LF	0.70	4.23	12.42	$3,037.27	☐
				Total Element Cost			**$3,037.27**	
				Total Technology Cost			**$3,037.27**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 11/5/2002 2:54:28 PM

Phase Technology Cost Detail Report
(without Markups)

Technology: STREAM BANK STABILIZATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	30.00	CY	5.74	0.95	1.96	$259.54	☐
17030433	Crawler Mounted 0.5 CY Hydraulic Excavator	20.00	HR	0.00	57.25	68.15	$2,507.95	☐
17030441	Standby 0.75 CY Wheel Loader	8.00	HR	0.00	0.00	68.15	$545.18	☐
17030705	D7 with U-blade Bulldozer	20.00	HR	0.00	32.01	106.19	$2,764.02	☐
17030713	Standby, D7 with U-blade Bulldozer	8.00	HR	0.00	0.00	24.67	$197.35	☐
17040101	General Area Cleanup	1.00	ACRE	0.00	169.24	107.46	$276.71	☐
17040103	Load & Haul Debris, 5 Miles, Dumptruck	100.00	CY	0.00	1.45	2.33	$378.24	☐
18050204	Rock Cover, Riprap, Heavy (25 to 500 Lb Pieces)	50.00	CY	17.69	3.31	2.10	$1,154.51	☐
18050206	Filter Barrier	100.00	LF	0.67	1.31	0.00	$197.76	☐
33080531	6 oz/sy Geotextile, Non-Woven (60 Mil)	120.00	SY	0.64	0.40	0.02	$126.80	☐
33220112	Field Technician	40.00	HR	0.00	15.81	0.00	$632.41	☐
				Total Element Cost			**$9,040.48**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 11/5/2002 2:54:28 PM

Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$9,040.48**

Phase Technology Cost Detail Report
(without Markups)

Technology: TOPSOIL AND SEEDING

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	4,557.00	CY	19.45	3.83	3.08	$120,104.29	☐
18050402	Seeding, Vegetative Cover	12.68	ACRE	3,572.78	64.32	51.49	$46,771.43	☐
18050413	Watering with 3,000-Gallon Tank Truck, per Pass	76.08	ACRE	4.02	24.47	29.70	$4,426.84	☐
				Total Element Cost			**$171,302.55**	
				Total Technology Cost			**$171,302.55**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	49.00	EA	8.15	0.00	0.00	$399.13	☐
33020402	Decontamination Materials per Sample	49.00	EA	7.33	0.00	0.00	$359.03	☐
33021509	Water Quality Parameter Testing Device	3.00	WK	232.56	0.00	0.00	$697.67	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	49.00	EA	205.54	0.00	0.00	$10,071.22	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	49.00	EA	324.75	0.00	0.00	$15,912.72	☐
33231186	Well Development Equipment Rental (weekly)	3.00	WK	232.56	0.00	0.00	$697.67	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	44.00	EA	9.50	0.00	0.00	$418.18	☐
				Total Element Cost			**$28,555.61**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	960.00	MI	0.36	0.00	0.00	$344.35	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	24.00	DAY	85.00	0.00	0.00	$2,040.00	☑
33220108	Project Scientist	221.00	HR	0.00	23.69	0.00	$5,235.45	☐
33220112	Field Technician	217.00	HR	0.00	15.81	0.00	$3,430.84	☐
33220114	Word Processing/Clerical	25.00	HR	0.00	13.10	0.00	$327.54	☐
33220115	Draftsman/CADD	25.00	HR	0.00	20.30	0.00	$507.60	☐
				Total Element Cost			**$11,885.78**	
				Total Technology Cost			**$40,441.38**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	25.00	EA	8.15	0.00	0.00	$203.64	☐
33020402	Decontamination Materials per Sample	25.00	EA	7.33	0.00	0.00	$183.18	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	25.00	EA	205.54	0.00	0.00	$5,138.38	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	25.00	EA	324.75	0.00	0.00	$8,118.73	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	22.00	EA	9.50	0.00	0.00	$209.09	☐
				Total Element Cost			**$14,318.13**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	420.00	MI	0.36	0.00	0.00	$150.65	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33220108	Project Scientist	113.00	HR	0.00	23.69	0.00	$2,676.95	☐
33220112	Field Technician	77.00	HR	0.00	15.81	0.00	$1,217.39	☐
33220114	Word Processing/Clerical	13.00	HR	0.00	13.10	0.00	$170.32	☐
33220115	Draftsman/CADD	13.00	HR	0.00	20.30	0.00	$263.95	☐
				Total Element Cost			**$5,159.27**	
				Total Technology Cost			**$19,477.40**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Monitoring (12 - months only)

Element: Groundwater

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33020401	Disposable Materials per Sample	13.00	EA	8.15	0.00	0.00	$105.89	☐
33020402	Decontamination Materials per Sample	13.00	EA	7.33	0.00	0.00	$95.25	☐
33021509	Water Quality Parameter Testing Device	1.00	WK	232.56	0.00	0.00	$232.56	☐
33021618	Volatile Organic Analysis (EPA 624), Water Analysis	13.00	EA	205.54	0.00	0.00	$2,671.96	☐
33021620	TAL Metals (EPA 6010/7000s), Water, Water Analysis	13.00	EA	324.75	0.00	0.00	$4,221.74	☐
33231186	Well Development Equipment Rental (weekly)	1.00	WK	232.56	0.00	0.00	$232.56	☐
33232407	Disposable Bailer, Polyethylene, 1.5" Outside Diameter x 36"	11.00	EA	9.50	0.00	0.00	$104.54	☐
				Total Element Cost			**$7,664.50**	

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	210.00	MI	0.36	0.00	0.00	$75.33	☐

Phase Technology Cost Detail Report
(without Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	59.00	HR	0.00	23.69	0.00	$1,397.70	☐
33220112	Field Technician	39.00	HR	0.00	15.81	0.00	$616.60	☐
33220114	Word Processing/Clerical	7.00	HR	0.00	13.10	0.00	$91.71	☐
33220115	Draftsman/CADD	7.00	HR	0.00	20.30	0.00	$142.13	☐
				Total Element Cost			**$2,663.47**	
				Total Technology Cost			**$10,327.96**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Ordnance & Explosive Institutional Controls

Element: Planning

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	4.00	DAY	85.00	0.00	0.00	$340.00	☑
33220108	Project Scientist	32.00	HR	0.00	23.69	0.00	$758.07	☐
33220114	Word Processing/Clerical	6.00	HR	0.00	13.10	0.00	$78.61	☐
33240101	Other Direct Costs	1.00	LS	8.37	0.00	0.00	$8.37	☑
				Total Element Cost			**$1,285.49**	

Element: Implementation

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010104	Car or Van Mileage Charge	280.00	MI	0.36	0.00	0.00	$100.44	☐
33010202	Per Diem (per person)	6.00	DAY	85.00	0.00	0.00	$510.00	☑
33220108	Project Scientist	98.00	HR	0.00	23.69	0.00	$2,321.60	☐
33240101	Other Direct Costs	1.00	LS	23.22	0.00	0.00	$23.22	☑
33990105	Letter/Brochure Printing and Distribution, per Page	50.00	EA	1.68	0.00	0.00	$84.08	☐
				Total Element Cost			**$3,039.33**	

Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$4,324.82**
Total Phase Cost	**$2,586,779.80**

APPENDIX D

ALTERNATIVE 5 COST ANALYSIS
EXCAVATION AND REMOVAL

ALTERNATIVE 5: EXCAVATION AND REMOVAL
PHASE COST OVER TIME REPORT (WITH MARKUPS)
LANDFILL 7/FPTA1 FEASIBILITY STUDY - F.E. WARREN AFB

Folder: FE Warren
Installation Name: Landfill 7 Feasibility Study
Installation ID: Landfill 7
Project Name: RA5 - Excavation and Removal LF7
Project Type: None
Project ID: RA5 - Excavation and Removal LF7

Phase Name: LF7 Excavation and Removal
Phase Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ
Start Date: 10/1/2003

Location: FE WARREN AFB (CHEYENNE), WYOMING
Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Technology Name	Fiscal Year Year 1 2004	Fiscal Year Year 2 2005	Fiscal Year Year 3 2006	Fiscal Year Year 4 2007	Fiscal Year Year 5 2008	Fiscal Year Year 6 2009	Fiscal Year Year 7 2010	Fiscal Year Year 8 2011	Fiscal Year Year 9 2012	Fiscal Year Year 10 2013	Fiscal Year Year 11 2014	Fiscal Year Year 12 2015	Fiscal Year Year 13 2016
Decontamination Facilities	$24,109												
Excavation	$3,365,585												
Load and Haul	$2,993,307												
Professional Labor Management	$1,433,988												
STREAM BANK STABILIZATION	$13,491												
TOPSOIL AND SEEDING	$226,453												
WELL ABANDONMENT	$4,146												
O&M: Miscellaneous Support Costs	$3,368	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382
Sub-Total	$8,064,447	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382
Discount Factor (5%)	1	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	1.710339358	1.795856326
NPV	$8,064,447	$3,551	$3,729	$3,915	$4,111	$4,316	$4,532	$4,759	$4,997	$5,247	$5,509	$5,784	$6,074

Technology Name	Fiscal Year Year 14 2017	Fiscal Year Year 15 2018	Fiscal Year Year 16 2019	Fiscal Year Year 17 2020	Fiscal Year Year 18 2021	Fiscal Year Year 19 2022	Fiscal Year Year 20 2023	Fiscal Year Year 21 2024	Fiscal Year Year 22 2025	Fiscal Year Year 23 2026	Fiscal Year Year 24 2027	Fiscal Year Year 25 2028	Fiscal Year Year 26 2029
Decontamination Facilities													
Excavation													
Load and Haul													
Professional Labor Management													
STREAM BANK STABILIZATION													
TOPSOIL AND SEEDING													
WELL ABANDONMENT													
O&M: Miscellaneous Support Costs	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382
Sub-Total	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382	$3,382
Discount Factor (5%)	1.885649142	1.979931599	2.078928179	2.182874588	2.292018318	2.406619234	2.526950195	2.653297705	2.78596259	2.92526072	3.071523756	3.225099944	3.386354941
NPV	$6,377	$6,696	$7,031	$7,382	$7,752	$8,139	$8,546	$8,973	$9,422	$9,893	$10,388	$10,907	$11,453

Technology Name	Fiscal Year Year 27 2030	Fiscal Year Year 28 2031	Fiscal Year Year 29 2032	Fiscal Year Year 30 2033	Row Total
Decontamination Facilities					$24,109
Excavation					$3,365,585
Load and Haul					$2,993,307
Professional Labor Management					$1,433,988
STREAM BANK STABILIZATION					$13,491
TOPSOIL AND SEEDING					$226,453
WELL ABANDONMENT					$4,146
O&M: Miscellaneous Support Costs	$3,382	$3,382	$3,382	$3,382	$101,446
Sub-Total	$3,382	$3,382	$3,382	$3,382	$8,162,525
Discount Factor (5%)	3.555672688	3.733456322	3.920129138	4.116135595	
NPV	$12,025	$12,627	$13,258	$13,921	$8,285,761

Cost Database Date: 2002
Cost Type: User-Defined
Date: 4/4/2003
Time: 11:15 AM

Phase Technology Cost Detail Report
(without Markups)

Folder: FE Warren

Installation

Name: Landfill 7 Feasibility Study
ID: Landfill 7
Location: FE WARREN AFB (CHEYENNE), WYOMING
Modifiers:

Material	1.0619	(Modified)
Labor	0.8413	(Modified)
Equipment	0.9676	(Modified)

Category: None
Report Option: Fiscal Year
Description: 12.68 acre landfill facility. LF7a - 5.65 ac, LF7b - 7.03 ac.

Project

Name: RA5 - Excavation and Removal LF7
ID: RA5 - Excavation and Removal LF7
Type: None
Description: Excavation and removal of the landfill units. Material will be hauled to an off-site disposal facility.

Phase

Name: LF7 Excavation and Removal
Type: Remedial Action
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate
Approach: Ex Situ

Media/Waste Type: Soil
Secondary Media/Waste Type: N/A
Contaminant: Metals
Secondary Contaminant: Semi-Volatile Organic Compounds (SVOCs)
Markup Template: System Defaults

Cost Database Date: 2002
Cost Type: User-Defined
Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Start Date: 10/1/2003 **O&M Markup Template:** System Defaults

Description: Excavation and Removal of the Landfill Units.

Phase Technology Cost Detail Report
(without Markups)

Technology: Excavation

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030279	4 CY, Crawler-mounted, Hydraulic Excavator	159,703.70	CY	0.00	0.58	1.86	$390,315.85	☐
17030418	Delivered & Dumped, Backfill with Stone	7,985.19	BCY	24.79	0.51	0.74	$207,916.78	☐
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	199,639.60	CY	5.74	0.95	1.96	$1,727,122.05	☐
33020401	Disposable Materials per Sample	40.00	EA	8.15	0.00	0.00	$325.82	☐
33021102	Soil Moisture Content ASTM D2216	40.00	EA	23.89	0.00	0.00	$955.71	☐
33021709	TAL Metals (EPA 6010/7000s), Soil Analysis	40.00	EA	324.75	0.00	0.00	$12,989.97	☐
33080584	Plastic Laminate Waste Pile Cover	1,487,715.00	SF	0.12	0.02	0.00	$199,056.27	☐
33170803	Decontaminate Heavy Equipment	1.00	EA	0.00	260.12	0.00	$260.12	☐
				Total Element Cost			**$2,538,942.57**	
				Total Technology Cost			**$2,538,942.57**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Technology: Decontamination Facilities

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030109	Pad Subgrade Preparation	35.56	CY	0.00	1.44	2.26	$131.69	☐
17030257	Cat 215, 1.0 CY, Soil, Shallow, Trenching	1.78	CY	0.00	0.45	0.67	$1.98	☐
17030501	Compact Subgrade, 2 Lifts	35.56	CY	0.00	0.15	0.25	$13.98	☐
17030510	Dry Roll Gravel, Steel Roller	106.67	SY	0.00	0.39	0.26	$69.04	☐
18010102	Gravel, Delivered & Dumped	14.81	CY	20.66	1.68	1.42	$351.85	☐
18010103	Gravel (90%) & Sand Base (10%), with Calcium Chloride 3/4 - 1 Lb/CY	14.81	CY	20.61	1.87	1.49	$354.93	☐
18010203	Asphalt Curb 8" W x 6" H	120.00	LF	1.46	1.92	3.11	$779.20	☐
18010310	Prime Coat	88.89	SY	0.33	0.03	0.03	$33.80	☐
18010312	Asphalt Wearing Course, 1 Pass (Line Item Includes 5% Waste)	19.33	TON	31.98	13.61	12.91	$1,130.86	☐
18020203	26" x 26", 5' Deep Area Drain with Grate	1.00	EA	1,600.45	860.29	20.86	$2,481.60	☐
19020313	5' x 5' x 5' Reinforced Concrete Sump	1.00	EA	1,537.81	1,216.99	73.58	$2,828.39	☐
19020604	12" x 12" CIP Concrete In-Ground Trench Drain with Metal Grate	20.00	LF	40.84	39.53	0.53	$1,617.88	☐

Phase Technology Cost Detail Report
(without Markups)

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
19040604	1,500 Gallon Steel Sump, Aboveground with Supports & Fittings	1.00	EA	1,697.07	644.31	0.00	$2,341.38	☐
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	144.00	LF	0.05	0.49	0.17	$101.95	☐
33080532	8 oz/sy Erosion Control/Drainage Filter Fabric (80 Mil)	106.67	SY	0.71	0.40	0.02	$120.67	☐
33080571	40 Mil Polymeric Liner, High-density Polyethylene	960.00	SF	0.29	0.84	0.17	$1,240.22	☐
33231306	High Sump Level Switch for Avoiding Overflow	1.00	EA	217.69	128.02	0.00	$345.71	☐
33260623	(2 1/2", 4") PVC Double-wall Piping, with Fittings	30.00	LF	16.55	16.79	0.00	$1,000.12	☐
33290401	25 GPM, 1 1/2" Discharge, Cast-iron Sump Pump	1.00	EA	2,147.02	296.37	0.00	$2,443.39	☐

Total Element Cost	**$17,388.64**
Total Technology Cost	**$17,388.64**

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Technology: Professional Labor Management

Element: Professional Labor Percentage

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33220138	Project Management Labor Cost	1.00	LS	0.00	99,629.94	0.00	$99,629.94	☑
33220139	Planning Documents Labor Cost	1.00	LS	0.00	99,629.94	0.00	$99,629.94	☑
33220140	Construction Oversight Labor Cost	1.00	LS	0.00	124,537.42	0.00	$124,537.42	☑
33220141	Reporting Labor Cost	1.00	LS	0.00	12,453.74	0.00	$12,453.74	☑
33220142	As-Built Drawings Labor Cost	1.00	LS	0.00	12,453.74	0.00	$12,453.74	☑
33220143	Public Notice Labor Cost	1.00	LS	0.00	1,743.52	0.00	$1,743.52	☑
33220144	Site Closure Activities Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220145	Permitting Labor Cost	1.00	LS	0.00	124,537.42	0.00	$124,537.42	☑
33220146	Responsible Party Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220147	Reimbursement Claims Preparation Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
33220148	Other Labor Cost	1.00	LS	0.00	0.00	0.00	$0.00	☐
				Total Element Cost			**$474,985.73**	
				Total Technology Cost			**$474,985.73**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Technology: Load and Haul

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17020401	Dump Charges	175,000.00	CY	5.00	0.00	0.00	$875,000.00	☑
17030226	988, 7.0 CY, Wheel Loader	563.00	HR	0.00	26.25	128.57	$87,165.52	☐
17030289	32 CY, Semi Dump	15,255.00	HR	0.00	21.03	62.85	$1,279,619.91	☐
				Total Element Cost			**$2,241,785.43**	
				Total Technology Cost			**$2,241,785.43**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Technology: TOPSOIL AND SEEDING

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
18050301	Topsoil, 6" Lifts, Off-Site	4,557.00	CY	19.45	3.83	3.08	$120,104.29	☐
18050402	Seeding, Vegetative Cover	12.68	ACRE	3,572.78	64.32	51.49	$46,771.43	☐
18050413	Watering with 3,000-Gallon Tank Truck, per Pass	76.08	ACRE	4.02	24.47	29.70	$4,426.84	☐
				Total Element Cost			**$171,302.55**	
				Total Technology Cost			**$171,302.55**	

Phase Technology Cost Detail Report
(without Markups)

Technology: Operations and Maintenance (12 - months only)

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33010202	Per Diem (per person)	8.00	DAY	85.00	0.00	0.00	$680.00	☑
33010205	Mobilize Crew, 50 Miles, per Person	8.00	EA	71.47	0.00	0.00	$571.76	☐
33220106	Staff Engineer	16.00	HR	0.00	23.22	0.00	$371.48	☐
33220112	Field Technician	16.00	HR	0.00	15.81	0.00	$252.96	☐
33240104	Startup Costs	1.00	LS	57.73	57.73	28.86	$144.32	☑
99020110	Annual Maintenance Materials and Labor	1.00	LS	0.00	0.00	0.00	$0.00	☐

Total Element Cost	**$2,020.54**
Total Technology Cost	**$2,020.54**
Runtime Percent Cost Adjustment	**97%**
O & M Total Cost	**$1,959.92**

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Technology: STREAM BANK STABILIZATION

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compaction	30.00	CY	5.74	0.95	1.96	$259.54	☐
17030433	Crawler Mounted 0.5 CY Hydraulic Excavator	20.00	HR	0.00	57.25	68.15	$2,507.95	☐
17030441	Standby 0.75 CY Wheel Loader	8.00	HR	0.00	0.00	68.15	$545.18	☐
17030705	D7 with U-blade Bulldozer	20.00	HR	0.00	32.01	106.19	$2,764.02	☐
17030713	Standby, D7 with U-blade Bulldozer	8.00	HR	0.00	0.00	24.67	$197.35	☐
17040101	General Area Cleanup	1.00	ACRE	0.00	169.24	107.46	$276.71	☐
17040103	Load & Haul Debris, 5 Miles, Dumptruck	100.00	CY	0.00	1.45	2.33	$378.24	☐
18050204	Rock Cover, Riprap, Heavy (25 to 500 Lb Pieces)	50.00	CY	17.69	3.31	2.10	$1,154.51	☐
18050206	Filter Barrier	100.00	LF	0.67	1.31	0.00	$197.76	☐
33080531	6 oz/sy Geotextile, Non-Woven (60 Mil)	120.00	SY	0.64	0.40	0.02	$126.80	☐
33220112	Field Technician	40.00	HR	0.00	15.81	0.00	$632.41	☐
				Total Element Cost			**$9,040.48**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

Phase Technology Cost Detail Report
(without Markups)

Total Technology Cost	**$9,040.48**

Phase Technology Cost Detail Report
(without Markups)

Technology: WELL ABANDONMENT

Element: N/A

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Extended Cost	Cost Override
33231822	Well Abandonment, 2" Well	175.00	LF	0.70	4.23	12.42	$3,037.27	☐
				Total Element Cost			**$3,037.27**	
				Total Technology Cost			**$3,037.27**	
				Total Phase Cost			**$5,458,442.59**	

Cost Database Date: 2002

Cost Type: User-Defined

Print Date: 4/4/2003 9:12:46 AM

APPENDIX E

RESPONSE TO WDEQ AND EPA COMMENTS

RESPONSE TO EPA COMMENTS ON DRAFT FINAL FEASIBILITY STUDY LANDFILL 7 AND FIRE PROTECTION TRAINING AREA 1 ZONE D, OPERABLE UNIT 10 F. E. WARREN AIR FORCE BASE, WYOMING NOVEMBER 2002

Comments are offered on the revised text below, most of which are readily addressable. One comment from prior comments requires a minor amount of specific follow through:

1. **EPA General Comment 4.** To minimize repetition, further comments will not be offered directly to the Executive Summary. However, revisions to other sections of the document will require corresponding changes to the Executive Summary.

   Response Evaluation: Most changes carried through. Identified changes still needed include:

   Page ES-1, 2nd sentence. Add "significant current" after "no".

   Response: The text in the Executive Summary has been revised to add "significant current" after "no" in the second sentence.

   "Although no significant current risks were identified in the Landfill 7 and FPTA1 Remedial Investigation (RI) report (United States Air Force [USAF] 2002b), this document addresses the characteristics of the landfill as they may affect potential future risk."

COMMENTS ON REVISIONS TO THE TEXT

2. Table 4-2, Page 2 of 4, Wyoming Water Quality Rules and Regulations, Chapter VIII. Two Comments:

   (1) This apparently compares to only the Class 1 ground water standards. For some of the metals (such as iron, manganese, and selenium), the lower of the Class 1 or Class 2 standard is the applicable standard. (Because established use places the ground water into both categories.) Clarify this in the "Comments" and assure the correct concentrations are reported.

   (2) In the "Comments" section (or with a footnote on the same page), identify the maximum detected background concentrations based on the 1999 Basewide background concentration study. Phrasing should be to the effect of: "Based on the Basewide background study (USAF, 1999), maximum detected background concentrations of iron, manganese (and selenium, if accurate) are greater than the standards within Chapter VIII.

These are: (list by name and concentration)." [Rationale: This phrasing is intended to state facts while allowing some flexibility for the scope of the RI/FS.]

Response (1): Table 4-2 has been revised to report the lower of the Class I or Class II groundwater standard. The selenium value has been changed from 0.05 mg/L, the Class III Livestock Standard to 0.01 mg/L, the Domestic Groundwater Standard. In all cases, the lower value reported in the table is the Class I Domestic Groundwater standard. A comment has been added to clarify that both standards apply and the most conservative value is used.

Response (2): The Comments section has been changed to add the background concentration of iron

> *"Based on the basewide background study (USAF, 1999) the maximum detected background concentration of iron is greater than the standard within Chapter VIII:*
>
> ***Iron** – 0.43 mg/L"*

3. Table 4-3, Page 6 of 9, Wyoming Air Quality Rules and Regulations, Chapter 6, Section 2. The 'Comments' discussion as phrased appears to exclude Alternatives 3 & 4 (or the phrasing for Alternative 5 is misplaced because it appears identical to the prior citation). Reconcile, correct, and/or clarify.

Response: Chapter 6, Section 2 of the Wyoming Air Quality Rules and Regulations would be applicable or relevant and appropriate to Alternatives 3, 4, and 5. Within Chapter 6 of the WAQRR contains the definition and regulations concerning the use of a Best Available Control Technology (BACT). Section 4(a)(vii) defines the meanings and implementation of BACT. Chapter 6 is applicable or relevant and appropriate to Alternatives 3, 4 and 5 to due the potential of those remedial actions to emit fugitive dust and off gas VOCs during excavation and construction activities. The 'Citation' section will be changed to broaden citation to the other applicable or relevant and appropriate sections within Chapter 6 such as Section 4(a)(vii). The 'Description' section of Chapter 6 has been changed to mention BACT. The 'Comments' section has been changed to better define the applicability or relevance of the citation and to differentiate it from the comments in Chapter 3 of WAQRR.

4. EPA also concurs with the comments offered by WDEQ (letter of 14 November 2002), identifying needed changes.

> **Response:** The WDEQ comments have been addressed and are presented after the EPA comments. Appropriate acronyms have been added.

5. There may or may not be a follow-through issue related to the Remedial Action Objectives (RAOs) as they pertain to addressing metals in ground water, usually iron and manganese. In this case, it depends on how the scope of this RI/FS is defined, specifically whether the scope is to address the ground water immediately associated with LF7/FPTA1. If this RI is to address the associated ground water, an RAO is needed to address restoration of ground water to beneficial use for contaminants potentially attributable to LF7. This would be primarily inorganics in this case, since the organic contaminants are attributable to Plume B or are otherwise below standards, risk-based concentrations, or to-be-considered criteria (such as the TPH). If the scope stays as defined (i.e., focused to landfill contents/systems above the water table), then the RAO to address metals is more appropriate for Zone D.

The LF7 RI addresses mobility to ground water through comparative analysis to Soil Screening Levels (SSLs) and comparisons to empirical data. Sampling data from LF7 wells were provided for the Zone D RI (and indicates the Zone D contractor sampled at least some of the same wells). Observations of upgradient to downgradient changes for aluminum, iron, and manganese are discussed in the LF7 RI and compared to background concentrations from the basewide study. While aluminum elevates, there is no standard for comparison, nor is a significant risk presented. Iron apparently varies (i.e., increases and then decreases along the apparent pathway; maximum detected 0.306 mg/l). This is sometimes above the WDEQ standard, but not above the maximum detected background (up to 2.3 mg/l) from the basewide background study (USAF, 1999).

Manganese is more problematic, with concentrations increasing from upgradient to downgradient. Concentrations in some downgradient wells were measured up to 0.55 mg/l. According to the 1999 study, the basewide background maximum is 0.15 mg/l. The LF7 RI identifies this as 'within the same order of magnitude', but was unable to identify whether these elevated concentrations were otherwise arguably background (i.e., formal statistical comparison, for which there is probably insufficient data). The basewide maximum background concentration is above the WDEQ standard and background would therefore be the 'enforceable' standard.

The Air Force, EPA, and WDEQ in the meantime have been having on-going discussions relevant to other RI/FS documents (Landfill 4 and the Zone D Groundwater investigations) regarding this same occurrence of metals. Additional discussion is anticipated.

Because EPA understood the scope of the LF7 RI to address primarily the landfill contents and ground water was to be addressed in the Zone D RI, EPA did not comment

on this in the context of this RI/FS. In the meetings of the project managers 19 November 2002, the Air Force indicated a somewhat different understanding (i.e., that the immediately associated groundwater beneath the landfill may have also been intended within the scope).

EPA is more concerned the RAO issue is satisfactorily addressed than over which RI/FS addresses the issue. It may be appropriate to consider more than one approach, depending on the situation. Therefore, this commentary is currently intended to serve as a 'place marker' for the issue. Depending on the Air Force's decision on the scope of this RI/FS, such as including the associated groundwater, this is a comment on the RAOs.

Response: The Air Force has expanded on the Landfill 7 Remedial Investigation to include a statistical analysis of the groundwater which focused on Iron and Manganese. Two different analysis were completed, the first using the Wilcoxon Rank Sum test which is outlined in the Baseline Risk Assessment Scoping Document Feb. 1999 and a second, a cumulative frequency analysis. Both of these tests showed that the data collected at Landfill 7 and the 1999 background samples were statistically similar data sets. It is the Air Force's position that these metals are naturally occurring and are within the statistical ranges of background. Below is an extract from the Revised Draft Final Remedial Investigation Landfill 7 and FPTA1 (January 2003):

> "Because iron and manganese were slightly above background and the secondary MCLs, a statistical analysis was performed to evaluate the site data set as compared to the 1999 background data set. This analysis, the Wilcoxon Rank Sum test which is outlined in the Baseline Risk Assessment Scoping Document Feb. 1999, showed that the Landfill 7 data set is log normally distributed and within the background data range. The one-tailed test results were, 0.196005 for iron and 0.1095805 for manganese. Both of these test results were greater then 0.05, which indicates that the data sets are within the same statistical population. The statistical analysis of iron and manganese determined that both metals statistically fall within the background data set and are therefore considered within background. A cumulative frequency analysis was also performed and depicted in a graphical analysis of lognormal data (Figure 4-8), which further supported that that this data statistically falls within the background data set."

Each of the proposed alternatives, with the exception of "No Action," includes monitoring of the groundwater, up and down gradient of the landfill.

RESPONSES TO WDEQ COMMENTS ON DRAFT FINAL FEASIBILITY STUDY LANDFILL 7 AND FIRE PROTECTION TRAINING AREA 1, ZONE D F. E. WARREN AIR FORCE BASE, WYOMING NOVEMBER 2002

Comment 1: The state acknowledges that some requested additions to Table 2-7 were presented in another table, Table 4-1. However, Table 4-1 still presents less information than the example Table A5-1 attached to our previous comments. Some portions of Table 4-1 need expansion. These include in particular the table section on Long term effectiveness and permanence, and, the table section on Implementability for each Alternative. For example, Table A5-1 discusses contamination remaining in groundwater at concentrations exceeding MCLs. This needs to be discussed for contaminants above standards and/or background in soil, surface water and groundwater. Also, the discussion of implementability of Institutional Controls in particular needs to be expanded similarly to that in Table A5-1.

> **Response:** The Long-term effectiveness and permanence and Implementability sections of Table 4-1 have been expanded to present adequate information for each alternative. The table has been included as an attachment to this document.

Comment 2: It appears that during the expansion of the document in response to comments, some acronyms and abbreviations were introduced without being added to the List of Acronyms and Abbreviations. Please see the attachment listing acronyms used that are not in the List of Acronyms and Abbreviations:

AOC	area of contamination
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene and xylene
BX	
CAA	Clean Air Act
CWA	Clean Water Act
CY	cubic yards
DOD	Department of Defense
DOT	Department of Transportation
EPCRA	Emergency Planning and Community Right-to-Know Act
ES	executive summary
ESA	Environmental Site Assessment
FPTA	Fire Protection Training Area
IDW	investigation derived waste
LDR	land disposal restrication
LF7	Landfill 7
LTM	long-term monitoring
MW	monitoring well
NCP	National Contingency Plan

NESHAPS	National Emission Standards for Hazardous Air Pollutants
OSWER	Office of Solid Waste and Emergency Response
PM	particulate matter
PVC	polyvinyl chloride
RPM	project manager
SDWA	Safe Drinking Water Act
TMV	toxicity, mobility, or volume
TPH	total petroleum hydrocarbon
VOC	volatile organic compound
WAQSR	Wyoming Air Quality Standards and Regulations
WCA	Waste Consolidation Area
WDEQ	Wyoming Department of Environmental Quality
WEDA	

Response: The List of Acronyms and Abbreviations has been modified to add the acronyms that were left out during the expansion of the document. The complete List of Acronyms and Abbreviations used in the FS has been attached for your convenience. This list has been updated in the Final FS:

LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BMP	Best Management Practice
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
COPEC	contaminant of potential ecological concern
CY	cubic yards
DAF	dilution attenuation factor
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPCRA	Emergency Planning and Community Right-to-Know Act
ERA	ecological risk assessment
ESA	Endangered Species Act
FEW	F.E. Warren Air Force Base
FPTA	Fire Protection Training Area
FS	Feasibility Study
FWS	U. S. Fish and Wildlife Service
GCL	geosynthetic clay liner
HAZWOPER	Hazardous Waste Operations and Emergency Response

HDPE	high-density polyethylene
HI	hazard index
HQ	hazard quotient
IDW	invesitgation derived waste
IRP	Installation Restoration Program
LCY	loose cubic yards
LOAEL	lowest observable adverse effect level
LTM	long-term monitoring
mg/kg	milligrams per kilogram
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Soild Waste and Emergency Response
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PPE	personal protective equipment
PVC	polyvinyl chloride
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SSL	soil screening level
TBC	to be considered
TCE	Trichloroethene
TCLP	toxicity characteristic leaching procedure
TMV	toxicity, mobility, or volume
TPH	total petroleum hydrocarbon
TRV	toxicity reference value
UCL	upper confidence limit
UCL95	95 percent UCL
USAF	United States Air Force
USC	United States Code
UXO	unexploded ordnance
VOC	volatile organic compound
WCA	Waste Consolidation Area
WDEQ	Wyoming Department of Environmental Quality
WHWRR	Wyoming Hazardous Waste Rules and Regulations
WWQRR	Wyoming Water Quality Rules and Regulations